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THE

JOURNAL OF SCIENCE.

JULY, 1883.

I. WASTE.

SOME time ago it was the fashion to extol the wonderful economy of "Nature." Did she not, in her anxiety to leave nothing unutilised, put ten plants or animals where there was only room, light, and nutriment for two or three? Did she not make the most of space by peopling both the outer surface and even the interior of animals with parasites? Did she not break up her products the moment their life had ceased, and use the materials over again, thus setting man an example which he as yet but very imperfectly follows?

Yet whilst fully admitting these and many other instances of thrift in Nature,—some of them carried out to the sore discomfiture of the beings wrought upon,—not a few minds have come to recognise an accompanying outlay of material and of power which from a human point of view is simply profligate. Men are actually beginning to write and speak about the extravagance of Nature. By way of exceptionally adopting a new fashion let us, too, consider the wastefulness so strangely and in seeming inconsistency mingled with parsimony. Is Nature in certain respects lavishly prodigal, expending means out of all fair proportion to the end to be produced?

Our notice is first drawn to certain facts connected with the propagation of plants and animals. We find that eggs, seeds, germs are produced in such abundance that not a tithe, not a hundredth, of them can possibly reach maturity. Of these seeds and ova the vast majority never germinate, never come to life at all. Many are devoured by predatory animals; and inasmuch as all are nourished by

organic matter, all animals are predatory. Many are destroyed by unfavourable circumstances, by extremes of temperature, by deficiency or excess of moisture. A fish deposits its spawn in stream or pool, and the water dries up in a rainless season; or a violent flood conveys the spawn along with the mud or sand away over the fields, and when it retires leaves them to perish. Of the seeds and germs of the vegetable world it is no exaggeration to say that only a fractional minority comes in contact with the soil at all. Numbers fall or are driven upon the leaves or stems of other plants, where it is impossible for them to germinate. Others fall upon surfaces of rock and stone; others again reach the soil, but where it is unsuitable in quality or in situations where their growth is rendered abortive by dense shade. An incalculable number of the seeds of land plants perish by being driven into rivers, lakes, and seas. More striking still is the waste of pollen, the male reproductive element of plants. In a great class of the vegetable kingdom, the so-called anemophilous plants—of which the grasses, the sedges, the firs, and pines are instances—this pollen is conveyed to the female organs of the species by the agency of the wind. Every particle which falls in any other situation is wasted. If we expose in spring-time, when such plants are in flower, plates of glass coated with glycerine, and afterwards examine them with the microscope, we recognise grains of pollen of many species. Thus we have proof that this fertilising element is distributed quite promiscuously. Hence if the flowers are to be fecundated the supply of pollen must be indefinitely greater than what would be sufficient if every grain were conveyed to the place where it is wanted. It has further been remarked by botanists that this waste has increased and is increasing. In other words, many plants, such as the grasses and sedges, formerly fertilised by the aid of insects, have become anemophilous—wind-fecundated—by a process of degeneration.

Believers in competition or "natural selection" may here perhaps urge that the destruction of seeds, germs, or ova, which we have just described, is but a part of the process which eliminates the individuals least fitted to survive. This, however, is not the case: when the seed has germinated, when the egg is hatched, the stronger and healthier young plant or animal may have a certain advantage as compared with its less vigorous and healthy rivals. But whilst the ovum or the seed remains such the chances of survival depend on no inherent attributes, but on purely external agencies, such as, for want of a better name, we are

forced to call accidental. A hundred seeds may have been produced by a most healthy plant, and they may have been matured by the most favourable weather; but all this will not in the least secure them from being devoured by birds, nor will it aid them in finding a patch of fertile soil. Precisely similar is the case with the eggs of animals. Thus we see that the first great process of elimination, which proscribes the many and lets the few survive, takes and can take no account of relative fitness or unfitness.

We may ask here what becomes of the pollen-grain which fails to come in contact with the stigma of a flower of its own species? what of the seed which never germinates, or of the egg which is never hatched? Most of them will sooner or later be devoured; some will putrefy, and contribute in their small way to the fertilisation of the soil; but it may well be asked whether this is a sufficient reason for the production of an excess of elements chemically and physiologically adapted for the perpetuation of animal and vegetable life. The soil, it appears to us, might be manured more cheaply; animals might be fed at a less outlay of energy and material. That the seeds of plants should serve as the food of animals seems in many respects to have been especially guarded against by Nature. Witness the number of species where the seed itself is enclosed in a shell, hard, prickly, indigestible, or of disagreeable taste: yet, whilst thus guarding many seeds from mishap, she produces them under circumstances where their ultimate germination is a work of chance. Again, it is well understood that the secretion of the sexual products is no slight demand upon the resources of the adult animal. In many species the male is exhausted by a simple act of fecundation, and the female dies almost immediately after depositing her eggs. Why should a task be laid upon them a hundredfold greater than really eventuates in the birth of the next generation? There is here, surely, if not direct waste, nothing that can rank as economy,—no attempt to produce the maximum effect, or at least the effect needed at a minimum outlay.

In close connexion with this part of the subject comes the reproduction of the feeble, the deformed, and the diseased. If we glance over the whole of the organic world we find in every species a wide range as regards strength, vigour, and approximation to what may be called the physical type of its kind. We find such differences prevailing not merely in man, in tame animals, and in cultivated plants, but among wild individuals. Now we may safely conclude, or rather we learn from experience, that the offspring of feeble and

diseased plants and animals inherit the parental shortcomings in a heightened degree; yet we find too often that bodily superiority in animal or plant is not necessarily accompanied by marked fecundity, and that, on the other hand, debility and sterility are far, very far, from keeping equal step. Who has not seen a mean, shabby, little oak tree,—a vegetable hobgoblin, and living libel on its species,—yet literally covered, season by season, with acorns? Who has not observed that, in our own species, the scrofulous and the phthisical have often more numerous families than the healthy and the robust? Now if, in accordance with the principles of heredity, the diseased tree or the diseased animal reproduces its like, we have here a case of waste. The young trees or the young animals sprung from such parentage will perhaps—and this is the best case—not reach maturity. In the struggle between species and species, or between individual and individual, they are soon trodden down, and are in the meantime simply an encumbrance. The food they consume and the space they occupy might have served a better purpose. And circumstances may sometimes make them a more important obstacle than their intrinsic powers might seem to warrant. An acorn of the miserable little oak tree we have been picturing may perchance fall into good unoccupied soil, whilst the fruit of the "Major-," the "Shambles-," or the "Parliament-" oak in "merrie Sherwoode" may be devoured by squirrels or be carried off to feed swine.

Not merely the progeny of the debilitated, but every animal and plant which fails to reach maturity, may be said to be an instance of waste. Especially is this the case in the human species. The world would be immensely the wealthier, as well as the happier, if all those multitudes of children who die before reaching maturity had never been born, and if the cost of their nurture and education could have been capitalised.

We turn now to a very different region. The importance of combined nitrogen—as distinct from free gaseous nitrogen—is beyond all dispute. It is a most important part of the food of plants, without which their growth, or indeed their life, is utterly impossible. From plants it is transferred to the animals which directly or indirectly feed upon them, and forms a most essential constituent of their blood, their flesh, their eggs, &c. In short, we may say that without combined nitrogen life—as it exists in this world—is simply impossible. Further, the stock of combined nitrogen present elsewhere than in plants and animals is by no means

unlimited. The atmosphere, the waters, and the soils have all been carefully analysed to determine their proportion of this constituent, but everywhere it has been found in very small quantities—mere traces. Thus, according to Fresenius, one million parts of air contain as an average only 0·133 part of ammonia. So that, roughly speaking, seven million pounds of atmospheric air contain 1 pound of ammonia. The combined nitrogen present in rain-water ranges from 8 to 65 parts in ten million parts. Again, not merely is the existing store of combined nitrogen thus very small, but we find hitherto no efficient provision for its increase or renewal. It was formerly believed that plants—some plants at least, such as clover, lucerne, peas, and beans—had the power of seizing the gaseous nitrogen of the air, and converting it in their tissues into ammonia, nitrates, or into organic compounds. Careful series of experiments, carried on in many cases in the hope that this might be true, have given, however, a uniformly negative answer. If we plant seeds in soil free from combined nitrogen, and pass over them only such air as has been carefully deprived of ammonia or nitric acid, we find in the dwarfed diminutive shoots which spring up no more combined nitrogen than pre-existed in the seed. A repetition of such experiments, under every variation of circumstances, has driven both scientific chemists and practical agriculturists to the conclusion that plants cannot assimilate or feed upon the free nitrogen of the air. As for animals, they have not even the least pretensions to the power which we find plants do not possess.

Nor have we been able to trace in the inorganic world any processes which meet the difficulty. Even the small proportion of ammonia found in the air is certainly in part—and we do not know in how great part—derived from the decomposition of animal and vegetable matter. We know that nitrogen can be made to combine with oxygen by electric sparks, or in other words by lightning. It has also been ascertained that the so-called effluve, or silent electric discharge, can induce the combination of nitrogen with hydrogen, thus forming ammonia. But these processes are exceedingly slow and little productive. It has lately been established that at great elevations in the atmosphere they are even less active than near the earth's surface. Thus water obtained from snow collected at high elevations in the Alps contains, according to M. Boussingault, no nitric acid, and in some cases no ammonia, the maximum proportion of the latter, at heights exceeding 3000 metres, being 1 part in ten millions.

We may therefore sum up by saying that combined nitrogen is indispensable to animal and vegetable life; that the world's stock of such combined nitrogen is relatively small; and that the processes for its increase or recovery are tedious, and not active. Surely we might, under these circumstances, expect that if Nature were a consistent economist she would most carefully watch over her supply of combined ammonia, and guard against its decomposition. Such, however, is not the case. M. J. Reiset has recently shown that a part of the nitrogen contained in the albumenoid matters of animals is set free during the transformations going on in the body, and escapes as gas. When the liquid and solid excretions of animals enter into putrefaction a part, indeed, of the nitrogen present reappears as ammonia or as nitric acid. But another portion is liberated, and takes the form of free nitrogen. A striking instance of this waste is seen in the case of sewage. Knowing the rain-fall and the water-supply of a town, and the amount of its population, we can form an approximate calculation of the quantity of nitrogenous matter which such sewage ought to contain. But if we then submit a sample of such sewage to analysis we shall find the result falls greatly below the most moderate estimate. From 20 to 50 per cent of the combined nitrogen originally present in the excreta has escaped in the free state, and has been wasted. In the "Journal of Science" for 1878 (p. 145) we discussed man's sins and shortcomings as regards the economy of nitrogen. We see now that Nature is guilty of waste of the very same kind.

It has lately been forced upon our attention that the permanent and decided enrichment of a soil by manuring is, as regards the nitrogenous constituents, difficult, if not absolutely out of the question. If we mix with the earth guano, blood, fish, or other nitrogenous matter, a rapid series of changes takes place. Not only does a part of the combined nitrogen escape in the free state, but the rest, under the influence of ferments present in the soil is rendered soluble far more rapidly than it is required or can be utilised by the growing crops, and is washed down and carried away in the drainage-water, passing ultimately into the sea. We have, indeed, no reason to suspect that it is in this process decomposed, but its immediate utilisation on the earth's surface is suspended. An enlightened economy condemns in man not merely the actual destruction of any useful matter, but its being locked up in an unavailable form, or, figuratively speaking, its withdrawal from circu-

lation. The miser of the old school, who buried his gold beneath the floor of his house, is pronounced a bad economist: had he, instead, invested it judiciously he might have become a much wealthier man. The fact that sooner or later the hoard is discovered and utilised does not cancel his error. Just in the same manner Nature has withdrawn from circulation a considerable part of her capital, and has kept it in such a state as to take no part in the transformations on which animal and vegetable life depend. The coal-beds, carboniferous and oily shales, &c., consist of the relics of vegetation which have been locked up for thousands of years in an inactive condition. We refer here not to the carbon and the hydrocarbons present, since carbon and hydrogen are elements so abundant that Nature has small cause to practise thrift as far as they are concerned. But coal, lignite, and their kindred minerals contain nitrogen in the combined state, sometimes in proportions exceeding 1 per cent. All this combined nitrogen, which in an article so plentiful as coal amounts to a prodigious quantity, has been for unknown ages rendered practically non-existent.

But it will be contended, in reply, man has, during the last few centuries, found these deposits, and is utilising them! True; just as the treasure-seeker sometimes finds the buried hoard of the miser or the pirate, and brings it more or less rationally into use. The discovery may be exceedingly convenient to such treasure-seeker, yet none the less the miser or the pirate was a bad economist. Why should Nature be judged differently.

We turn again in a totally different direction. Suppose that there exist a number of different machines or appliances whatsoever for executing one and the same task. Suppose, further, that these contrivances differ much among themselves in their relative degree of excellence and efficiency. We may take, for example, the boomerang, the sling, the bow, the match-lock, the flint-lock, the muzzle-loading rifle, and the breech-loader. Or, as another instance, let us compare, as means of transporting merchandise, the pack-horse, the stage-waggon, and the goods-train. If a manufacturer employed, and continued to employ, all these three kinds of conveyance for transporting the same kind of goods to the same place, he would not unjustly be pronounced a bad economist. Yet this is precisely what Nature does. We find her employing a number of different agents to effect some one purpose, and she even gives a preference to those which work in the least satisfactory manner. Thus we see the removal of putrescent and excrementitious matter

committed to a number of beings who proceed on very different principles. Some, such as the dung-beetles and sexton-beetles, bury the offensive matter in the earth, so that its odours and other exhalations are absorbed by the soil, and cease to be a nuisance. These creatures, moreover, prey on no other kind of matter, so that there is no fear of taint or disease being spread by their agency. Hence they may be called model scavengers. Others again, among which a great number of two-winged flies may be included, eat carrion and excrement, and deposit their eggs in it, but leave it on the surface of the earth, and for the time being intensify its putrefaction. Further, these flies do not confine themselves to putrescent matter, but settle upon and feed on a great variety of substances, living or lifeless, and thus spread decomposition and disease. They are, in fact, the worst of conceivable scavengers. Where they remove one nuisance they occasion ten. Yet Nature employs them, it would seem, in preference to the perfect sanitary workers previously mentioned. In preference, we say, because the bad workers seem to become more plentiful, whilst the perfect workers are losing ground.

We have thus attempted to give not a catalogue, but merely a few instances where Nature does not appear to act according to the principles of economy, but rather of carelessness and waste. On what system such prodigality is intermingled with a parsimony so extreme as in some cases to defeat its own ends, we are unable to explain.

II. SOME ETHNOLOGICAL OBSERVATIONS.

By Cl. de Crespigny.

HAVING read somewhere that Jewesses in Eastern Europe have their heads shaved at marriage, and ever afterwards wear wigs, it occurred to me that this might be a custom derived from the Ancient Egyptians, who we know wore them habitually,—perhaps that when in private they might, by taking them off, enjoy more coolness than if they wore their natural hair.

Having read in your Journal that the Australian aborigines are in the habit of burying their excrements, I remembered a sojourn of fourteen months once endured by me in St. David's Islands, off the north coast of New Guinea. The inhabitants were in all eight, *viz.*, two old men, two young men, one old woman, one young woman, who was a widow with two children—daughters. These people buried their excrements in the sands of the sea-shore. Another very peculiar custom I observed was that the widow, once a month, when her times were upon her, was considered unclean, and went to live for a few days with her two children in a hut near the beach, just within shade of the fringing cocoa-nut trees. Her friends brought food every day, and enquired after her health, but did not approach to within a few yards of her, nor would they, even while she was in retirement, pass between her and the sea. Even if walking on the beach they would, on approaching her hut, make a *détour* within the trees, coming out on to the beach again on getting past the hut.

There were some graves in which they said were deposited the bones of chiefs (the islands had formerly been more populous). They said that they hove into the sea, beyond the surrounding coral barrier, the corpses of common people. I asked if they had any idea that their dead friends would live again? and they said "No, pitch 'em overboard, and there's an end of them."

These people, although they lived in a group of cocoa-nut islands, did not know how to make oil, and were astonished at the brilliancy of my reading-lamp, fed with oil made on the spot by my servants.

The men had sometimes gone whaling for a few months, in ships which lay to off their reefs, and had acquired some phrases of English. Thus they called sunrise and sunset "sun up" and "sun down." In offering me a drink of toddy they would say "Put it out of sight." But they had not been taught to swear. I remember that the name of one man was Merriwitty, evidently from some sailor named Meriweather; that of another was Mollymock (? Dollymop).

They said that many years before a large boat, having in her about thirty men, had been blown from the N.W. to their islands. The strangers spoke the same language as they did. After a visit of about ten days' duration these people left again for the N.W. (I thought these visitors might be from St. Andrew's Islands), The St. David's people said they had never been in the habit of sailing

anywhere, nor had they ever before, within the bounds of tradition, received visits from the N.W.

Some years before my arrival a large body of pirates had made a sudden descent on their islands, and carried off nearly all the inhabitants. Those who escaped did so by paddling out to sea, and remaining there some days, keeping the tops of the trees just within sight. This expedition, as I learnt afterwards, had been sent by the Sultan of *Zi*dore, and was not considered by the Dutch as an act of piracy; and I believe some correspondence took place with the English Government in consequence of the late Sir Edward Belcher having been of a different opinion.

St. David's, or Free Will, Islands are—or rather the largest of them is—called Mapia.

III. OBSERVATIONS ON POLLUTED WATERS.

By J. W. Slater.

THE self-purifying power of polluted rivers, and still more of town sewage, has been the subject of no little discussion, and is still far from having been brought to a decision. I have, in a former volume of the "Journal of Science" (1881, p. 138), referred to the opposite conclusion, which has been reached by the late Royal Rivers Pollution Commissioners, on the one hand, and, on the other, by Dr. Tidy, and by a French chemist whose name has escaped me, but who made a very minute study of the waters of the Vesle, above, at, and below the town of Rheims.

The first-mentioned authorities,—perhaps we should rather say authority,—without declaring in general terms that a river once contaminated could not purify itself again, maintained that at any rate no such restoration was possible within the length of any river in the United Kingdom. Dr. Tidy is of a different opinion, and the French chemist above referred to gives an instance where the gradual change from purity to pollution, and thence back again to purity, may be seen by anyone who is willing to spend a day in examining

the Vesle above and below Rheims. The alleged changes are the more striking as the Vesle is not a river of enormous length. If we allow thirty-six hours as the length of time required by a drop of water from the clean regions above the "French Leeds" to the clean regions below, we shall be on the outside of the truth.

To throw a little more light upon the subject I took three kinds of water: 1st, raw, undiluted sewage, which I obtained from Aylesbury; 2nd, similar sewage partially purified; and 3rd, sewage fully purified, as it passes from the works of the Native Guano Company into one of the branches of the Thames. The sewage in question is strongly animalised, containing, in addition to the usual excrementitious matters and liquid household refuse, a somewhat unusual proportion of blood, derived from the cattle slaughtered in Aylesbury for the London dead-meat market. What may be called industrial contamination is totally absent. Of each of these three kinds of water the one-half was filtered and the other left in its original state. I had, therefore, now six kinds of water in my hands. Of each of the six I placed portions, differing in bulk, in a number of white glass pint bottles, loosely stoppered, and arranged on a shelf exposed to the morning sun. In some of the bottles the stratum of water was 1½ inches in depth; in others 3, 4, &c., up to 6 inches. The bottles were now regularly examined to see what changes would take place. In the bottle containing the best purified water, filtered, and in a shallow layer, a green confervoid vegetation appeared in a couple of days; it increased, and bubbles of oxygen were formed and rose to the surface. There was no offensive odour. Similar phenomena were observed later in the other bottles; but eight weeks passed over before green vegetation appeared in the bottle containing 6 inches in depth of raw unfiltered sewage. In the meantime the odour given off from this bottle had been very offensive. It must also be remarked that in this bottle, along with the green confervoid growths, there appeared a small quantity of white sewage-fungus, which was only gradually burnt up by the oxygen liberated by the green vegetation.*

Hence it would appear that, according to common belief, the appearance of green vegetation, unaccompanied by white fungoid matter, is a favourable sign; that sewage can purify itself, but that the process is very slow; that the

* This is the first time that I have watched the appearance of sewage-fungus in stagnant water.

speed with which the impurities in a water are destroyed is greater where it is spread out in shallow layers to the action of air and light, and where its transparency is not interfered with by suspended matter; that the self-purification of sewage is of no practical value, since during the greater part of the process it is exceedingly offensive, and since to let it stand in shallow settling tanks would be ruinously costly.

The speed of purification would doubtless be increased no little if it were in motion instead of at rest. Further, not even the most polluted river contains the same proportion of impurities as the undiluted and untreated sewage used in some of the above-mentioned experiments. It will likewise be admitted that in a river, well stocked with water-plants, the oxidation of the impurities will be more rapid than where such vegetation has first to be developed. On the other hand, there are in practice circumstances met with which must interfere with the combustion of the organic matter held in solution. In the sewage of manufacturing towns and mining districts there may be poisons which prevent vegetation of any kind, chlorophyllaceous or otherwise. The great opacity of certain sewages will also retard purification by excluding the light.

Bearing all the above facts in mind, we shall find that the conflict between the authorities above mentioned is probably more apparent than real. There are many rivers in the manufacturing districts of England polluted to such a pitch that vegetation in them is impossible, and the great self-purifying agency is thus suspended. I can very well imagine that an analysis of the water of the Irwell, at its junction with the Mersey, will show the same impurities, and substantially in the same proportion, as are found in the river where it leaves Manchester. I should expect that the waters of the Aire or of the Calder will, in like manner, show no improvement in 10 or 15 miles from their most polluted point. I should expect this to be the case because the flora and the fauna of the water remain the same. But with the Vesle, at Rheims, the case is plainly different. We read of green aquatic vegetation reappearing below the town, and becoming more vigorous within the space of a few miles. Hence the means for the purification of the water being present, we need feel no surprise that the effect is produced. If Prof. Frankland had made his observations on the Vesle he would have come to the same conclusions as his French *confrère;* and if the latter had been sent to study the Mersey, the Irwell, or the Aire, he would in turn have given it as his opinion that

there was no natural process by which their purification could be effected within the course of any British stream.

I come now to the second part of my subject: can fish live in sewage? It is somewhat curious that the affirmation should still be maintained. Perhaps the very first impulse to the movement for preventing the pollution of rivers in Britain was due to the observation that the contrary is the case. Said the riparian proprietor to the people of the town next above him on the stream, "Your sewage is destroying my fish,"—and this destruction has been one of the reasons why in such cases injunctions for the abatement of the nuisance have been issued. It will not do to say that the fish are killed not so much by sewage, properly so called, as by the waste waters of various factories. True lime, the hypochlorites, sulphate of soda, coal-tar products, and a long string of other bodies which find their way into our rivers, have played sad havoc among fish. But whoever will make careful inquiry will find that fish have also disappeared, though more gradually, where nothing but sewage —in the strict sense of the term—has found its way into the rivers. I have seen ("Journal of Science." 1881, p. 144) fishes darting about in the Thames at the spot where the Kingston sewer then opened, and I have heard that the locality was on this account much frequented by anglers. But I was also told that the fish caught in such localities enters into putrefaction with unusual rapidity. Hence, I think, it may be fairly argued that such fish are in a morbid condition, and that the circumstances to which they are exposed must sooner or later bring on their destruction, as we in fact find is the case in rivers where sewage pollution is great. As long as the volume of sewage is but small in comparison with the bulk of clean water, they will survive, and will visit the sewer outfall for feeding purposes, attracted by the larvæ of various kinds and by the particles of human food brought down by the impure water. But we have no evidence to show that this sewer haunting is conducive to their health or multplication. On the contrary, if we only observe carefully, we find that it is destructive to them, some species resisting longer than others. That excrementitious matter, *per se*, is avoided by fishes we have observations to prove. An intelligent Parisian *ravageur* states, in the "Moniteur Scientifique Quesneville," that fishes avoid any particularly offensive discharge of matter from the mouth of the sewer, and hide themselves among the weeds till the nuisance has passed. I have observed from time to time, and in different places, shoals of minnows playing about the

mouth of a sewer, but on careful examination I have rarely failed to note some dead specimens floating on the surface.

It is very plain, on theoretical considerations, that sewage, or water containing a large proportion of sewage, must be fatal to fishes as a medium for constant residence. We know that they breathe not the oxygen existing in combination with hydrogen in the water, but the free oxygen which has been dissolved in the water. It has been found that fish quickly perish in water which has been boiled and allowed to cool in a closed vessel without agitation. Now in sewage, and in sewage-polluted river-water, it is analytically demonstrable that the proportion of free oxygen is very much reduced. The various kinds of organic matter undergoing rapid changes use up the available oxygen, and unless aëration is effected by rapid motion, or by the action of water-vegetation, fish are in the same condition as a man would be if placed in a highly rarefied atmosphere. In consequence they must either retire from the danger or ultimately perish.

It must not be supposed that this deprivation of free oxygen is the only reason why fish are unable to survive in polluted waters; but it is a cause readily demonstrable, and one which cannot fail in its action. But many of the agents employed by individuals or by communities, for lessening or preventing the offensiveness of sewage, render it even more destructive to fish. It is known that not a few sewage processes employ lime, not merely to correct the acidity sometimes met with in industrial waste waters, but as a positive precipitant. I know of a case where 16 tons of quicklime have been put daily into the sewage of a single town, unaccompanied by any corresponding dose of an acid or of an acid salt. In all such cases the effluent water has a faint alkaline reaction; it is, in fact, weak lime-water. Now everyone surely knows that lime is hostile to fish, and indeed to water-vegetation. By putting a few lumps of quicklime into a stream, poachers often succeed in killing the fish for a considerable distance. We must therefore readily admit that where the introduction of lime is continuous, fish cannot prosper. It may be argued that lime-water on exposure to the air becomes harmless, all its lime being converted, by the carbonic acid of the air, into calcium carbonate, in which state it is very sparingly soluble; but when the quantity of lime-water introduced into a slowly-flowing river is great and continuous, the water must travel for many miles before this conversion can be effected. Hence I can but advise riparian proprietors, lessees of

fisheries, and brethren of the angle to set their faces against all sewage processes in which lime is used, either alone or without its equivalent of an acid or acid salt.

All these processes are to be condemned, from the same point of view in which salts or other compounds greedy of oxygen are run into the rivers. Ferrous sulphate, or copperas, ranks among these agents. In like manner any alkaline or earthy alkaline sulphide, or any compound from which sulphuretted hydrogen can be evolved, should be used in the treatment of sewage. Such substances not merely rob the water of its oxygen, but act as positive poisons.

IV. POLYDESMUS COMPLANATUS.

By A. H. Swinton.

At a late meeting of the Entomological Society of London, Professor Westwood stated, as an item of Economic Entomology, that the myriapod *Polydesmus complanatus*, L., had been gravely accused in a Sussex newspaper of being the cause of the potato disease.

Observing a paragraph headed "The Cause of the Potato Disease," in the "Sussex Gazette," on the 23rd of last March, I was led to inquire into the nature of this startling announcement. The writer, Mr. Jesse Page, an agriculturist of the sister county, very obligingly took me into confidence, and explained that he was under the conviction that the mischief among his potatoes arose from the presence of a mysterious insect, whose habits he had been watching these thirty years past, and which as yet no one could be found to publicly name. The following humorous extract from his communication on the subject will sufficiently explain the views he had been led to adopt:—"I got out into my garden yesterday for the first time, where I had a man digging ground which had been planted with potatoes all the winter. I searched for some time, and then I found two insects evidently intending to breed there. And this is the beginning of my theory. The insect breeds in the old set, and wisons it, and causes it to rot prematurely, and when the potato dies people examine the haulm to find out the cause."

As mutual assistance is imperative with those who desire to turn natural science to account, I drop a friendly line to my new correspondent, offering to co-operate with him in his researches, and to render him any aid that lay in my power. Expectation stood tiptoe for a day or so, and then there comes a little box by the post, enclosing some carefully hoarded fragments of the insect in question, with further intimation that live examples would follow by the carrier. A glance at the enclosure showed me that my correspondent was correct in his assertion that the marvellous insect was of the myriapod class, and on reflection it occurred that the only party who was likely to have bestowed much attention on this order would be Prof. Westwood, and to him I decided to refer the matter.

A few days went by, and I received a reply to say that the insects supposed to be the cause of the potato disease were without doubt the *Polydesmus complanatus*, one of the Myriapoda. The Professor, however, deprecated their being supposed the cause of the disease, and added that he had no doubt but that they might be found in diseased potatoes, just as a score of other insects of different kinds, concerning which the French writer Guérin gave an account, in 1845, in his "Memoire sur les Acariens, les Myriapodes, les Insectes et les Helminthes, descrivées jusqu' ici dans les pomme de terre malades." The *Polydesmus*, I should perhaps observe, is a pale whity-brown insect, which must be familiar to most potato-growers. Though a centipede in form, it has only seven joints to its feelers or antennæ, and it is therefore more nearly akin to the wood-louse and cylindrical myriapod than to the brown centipedes and Scolopendras of the tropics, which have fourteen.

The potato disease, as is well known, is due to a fungus or mildew called *Peronospora infestans*, and I gather the following particulars concerning its spread from an article by a relative of mine, Dr. Galbraith, of the Stirling Natural History and Archæological Society, who has made a speciality of the matter:—The spores or capsules of this mildew are of two kinds, and they have the marvellous property, when moistened, of absorbing the moisture and bursting, by which means numerous living seeds—if it be permissible to so translate the learned term applied to them—are set free. These living seeds or zoospores move about by means of their fringes or cilia, and germinate within from an hour and a half to three hours after the spores are sown. One of the two kinds of spores or seed capsules hybernates or remains dormant throughout the winter season, and these propagate the disease from year to year.

The same authority adds—"I frequently find diseased potatoes at the root of the most flourishing and healthy-looking shaws. As to the potatoes, I have seen very few of them pass into a state of moist corruption; neither have I been struck with an offensive smell given out by the plants, which, however, counts for little, seeing the olfactory sense varies. The tubers affected are easily recognised by the dark spots on the skin. If this is scraped off the subjacent tissue is seen to be of a brown mottled colour, which permeates more or less extensively the naturally white flesh of the potato. When extensively diseased the potato loses its natural smoothness and colour, and is converted into a dark, rough, heavy mass."

Although competent microscopists, by the plan of hanging up wetted sheets of paper and afterwards submitting them to the microscope, have conclusively proved that the air around us is full of all manner of floating spores, I would have willingly credited my correspondent's assertion that the mysterious myriapod might be guilty of spreading the infection. However, putting the matter to test, and enclosing the said myriapod with a choice example of a Sussex kidney, I then discovered conclusively it would not touch it, and that its nature was to prefer decaying leaves, agreeably to the taste of its kind and the remark of Prof. Westwood, that "the Myriapoda delight in decaying vegetables." Afterwards I introduced a couple of earwigs on the scene, and these, indubitably the more mischievous of the two, soon riddled and fairly consumed the potato.

But to return to the main point. It is evident that moisture is necessary to extend the evil of the potato disease, and consequently there is less fear of it when the summer is hot and dry than when the season is characterised by much moisture, and more particularly moisture accompanied with warmth, when myriapods doubtless abound. It has also been observed that thunderstorms, with the usually concomitant rain, are sure to be followed by an active development of disease among the potato plants.

Though the potato was introduced into Lancashire from Virginia, in America, by Sir Walter Raleigh, about the year 1586, the disease is stated to be quite a recent importation. The year 1846, that followed on its first invasion, was the worst year known: 1860 was likewise a bad one; and it was bad in Ireland from 1876 to 1879: then last year it was said that the growers of potatoes were everywhere at their wit's end. Certainly this spring potatoes in Surrey have been proverbially bad, and villanously "dark, rough, and

heavy." Where the disease came from appears not to be distinctly known: the potato crops of Belgium suffered from it in 1842, and in 1844 it was noticed in the United States of America and in the Isle of Wight.

Now it would be hardly imagined at first sight that, supposing a wet year—or, as growers say, the rains that come between June and the close of October—be proved to bring about a state of matters favourable to the spread of the potato disease, we could thence argue the probable periodicity of its recurrence. There is, however, a growing feeling among our first meteorologists that we have all along been ignoring the sun's influence over the rainfall and the growth of vegetation. Certain is it that the sun blackens over with spots about every eleven years, and three or four years previously to this spottiness it is at its brightest. To these sun phases, as Mr. Norman Lockyer has lately officially stated, "the rainfall of our globe has been in measure determined to respond." No marvel, then,—when we discover that in 1846, 1860, and 1882, the sun was very much spotted over and the potato disease very rife,—we should entertain qualms about 1890 or 1900, when we may expect the spots back again. The visitation of the potato disease in Ireland from 1876 to 1879, on the other hand, corresponds with the period of solar clearness preceding 1882, at which times there is evidence to show that the summer rainfall is often in excess.

Lastly, when speaking of these phases of fitful brightness and spottiness of our day-star, and their appointed rule over mundane affairs, I might allude to an interesting theological scientific discussion that has taken its rise with the sun-spot year of 1882. Early this spring my friend Mr. Kirsop, of the Glasgow Natural-History Society, knowing me to be interested in Solar Physics, favoured me with the following newspaper-cutting, headed "The Star of Bethlehem":—

"A recent telegram from a Berlin correspondent mentioned that the Star of Bethlehem was predicted to reappear during the current or next year. The prediction is based on the supposition that certain stars of the class known as 'temporary' are simply reappearances of the same orb. Pliny mentions that the sudden appearance of a bright star, which after a time vanished again, led to the formation of the first catalogue of stars, which was compiled by Hipparchus. This statement is corroborated by the Chinese records, in which the rise of a new star in the constellation Scorpio is mentioned in the year 134 B.C., nine years prior to the date of Hipparchus's catalogue."

To this Virgil probably makes reference in the well-known lines :—

> " Anne novum tardis sidus te mensibus addas,
> Quâ locus Erigonen inter Chelasque sequentes
> Panditur : ipse tibi jam brachia contrahit ardens
> Scorpius, et cœli justâ plus parte reliquit."

" In the year 389 A.D. a star appeared near Altair, which remained visible for three weeks, rivalling the planet Venus in splendour. The next orbs of this class of which we have accounts are those mentioned by our correspondent, namely, those of 945, 1264, and 1572. Accounts of the 945 and 1264 are very vague, but it is known that the stars were located near Cassiopeia. The star of 1572 was observed by Tycho Brahe, the celebrated Danish astronomer, who devoted 478 closely-printed pages to its description. Tycho's attention was drawn to the star, while passing from his laboratory to his dwelling (on November 11th, 1572), by some peasants who were gazing at it. At the time of discovery its brilliancy equalled Sirius (the dog star), and it went on increasing until it surpassed Jupiter and Venus, and ultimately became visible at mid-day; then it gradually faded away, passing out of sight in March, 1574. During the previous seventeen months its position was unaltered, but it is said to have changed in colour from white to yellow, red, and white successively. There is now a very small star within a very slight distance of the position recorded by Tycho, and, from the observations of Messrs. Hind and Plummer, its light appears sensibly variable. Very bright stars also appeared in 1604 and 1670 : the former, in Ophiuchus, lasting over a year, and being at times nearly as bright as Venus; the latter, in Cygnus, lasted two years, during which it reached the third magnitude, faded away, and shone forth again on more than one occasion prior to its final disappearance. During the present century similar luminaries have been observed to attain an unwonted degree of brightness, and then fade away until only the most powerful telescopes can detect any trace of them. A comparison of the dates given (945, 1264, 1572) shows a difference in the period which our present knowledge cannot account for, but astronomers of a future generation may possess information not at the command of those to-day, and thus account for that which to us is veiled in mystery."

The next notice of the Star of Bethlehem caught my eye in " Science Gossip " for May, the writer professing himself credulous on the subject. He says—" The American papers are discussing the expected reappearance of this star, which

will be seen in the constellation Cassiopeia about August, 1887. It is said to be the same star that appeared at the birth of Christ, and only appears once in 312 years. It is not to be supposed that astrologers would allow so extraordinary a phenomenon to pass unnoticed, and many prodigies may be expected to occur." In the number of the same publication for June a member of the Astronomical Society reviews the religious aspect of the belief. He disposes of the supposed star of 1264 as the splendid comet seen the year of the battle of Lewes, and mentioned by all the historians of that period. "And with regard to the Star of the Nativity nothing can be more evident, as was pointed out by St. Chrysostom, than that it was a miraculous appearance in the form of a star (perhaps visible, as many divines think, to the Magi only), sent expressly to indicate the Saviour's birth." In such a case, however, we have St. Jerome and the authors of the Revised Text brought into strange conflict; for not only the words "in the likeness of" do not occur, but Herod is represented as enquiring of the Magi concerning the time of the star that appeared. Again, since Bethlehem is only 5 miles distance from Jerusalem and a trifle to the westward, I conclude that there is no paramount reason that a strange star should not go before the Magi. A certain sensational painter, however, has priority in such matters, as a well-known print has long flared in the bookseller's window, where the Star of Bethlehem is depicted as something between a bombshell and a comet.

V. THOUGHT READING.*

By Rev. H. H. Higgins, M.A.

THE limited time at my disposal induces me at once to state my belief that the process known as "thought reading" is characterised by genuine phenomena which are in perfect accordance with the natural laws recognised in the science of Mental Physiology.

* The substance of this article has been read in a paper before the Philosophical Society of Liverpool.

We have a mere secondary interest in the multitude of complicated adventitious circumstances usually attending a popular exhibition of thought reading. Such circumstances form the staple of the observations and remarks ordinarily made on the subject. The very simplest case is best suited for our purpose, and one *true* example is as good as a thousand.

I will endeavour to define what I understand by thought reading, and then to show that its exercise is compatible with scientific principles. The individual who undertakes to read the thoughts of another is called the operator; he whose thought is read is called the subject. I will call the operator A, and the subject B.

If A know the thought of B by an impression, ever so subtle, received through any of the senses, such as touch, sight, or hearing, then A's knowledge is not gained by thought reading, though B may be perfectly unconscious of having afforded an intimation of his thought to A, in any way whatever.

Probably such accessories to apparent success are used by certain public operators so as in a wonderfully keen and sagacious manner to avoid failures. I have no doubt that there are others who are altogether above such trickery. Of course there is a *rapport* of some kind, or the thing would be a miracle. If it be always a sense impression, thought reading must, I think, be classed with table-turning. But if A, guided by no sensuous impression, can, through *quasi* electric relation with B, proceed to say or do something having an unmistakable affinity with a thought entertained by B, but otherwise unknown to A, *that* is thought reading, of which I shall attempt to show the reasonableness.

All of us remember table-turning. Many men of science said "The whole thing is an imposture, not to be explained but scouted." If it had been left to these men table-turning might be in vogue now. For in spite of the thing being scouted, the tables *did* turn, no one knew how. For table-turners were not all impostors, but were themselves deceived. Faraday gave a scientific explanation of the fact, and table-turning died a natural death through atrophy.

I am far from anticipating such an end for thought reading, which may possibly prove to be of some remedial value in certain forms of insanity.

There are, I conceive, called into exercise in every instance of thought reading, two distinct constituents,—first, the ordinary nerve currents; and secondly, an abnormal exaltation of the sensitiveness of some portion of the cerebra system, or sensorium, of A.

First, then, as to the currents. There is no need to invoke the aid of any special psychic or odic force. We know that between the brain and every part of the body a most intimate connection is kept up by means of the nerves, along which, as along telegraph wires, currents continually pass and repass. The word current is misleading. We must not suppose that matter of any kind is transmitted; neither is nerve current exactly a wave motion, but it is rather a succession of impulses. Professor Clifford compared nerve current with the motion in a row of card houses, when the end house is shoved against the next. The fall of the whole series is very satisfactory to see, the only drawback being that all the cards must be put up again before the experiment can be repeated.

It seemed to me essential that you should form a clear conception of motion along a line without transmission of anything. I therefore reconstructed from memory a toy which was a great favourite with me about sixty years ago, and which may be qualified for introduction to a scientific meeting by being named a "statoract."

It is plain, then, that very active motion may be set up along a line without a particle of matter being transmitted. If you will be so kind as to imagine the plaques of wood to be magnified molecules, you will the better appreciate Prof. Clifford's remark on nerve currents. He says that if we could magnify the molecules 50,000,000 diameters, we might see them falling one against another; but he warns us that we should not, even in that case, be any nearer seeing thought or consciousness.

Nerve current is very similar to that of electricity, but the two are not known to be correlated or convertible, though nerve current is said to be always associated with electric current.

In Dr. Rosenthal's account of M. E. du Bois Reymond's experiment, in which the index of an electrometer is made to move by an effort of the will, it seems probable that electricity, thus associated, is the agent.

I have not space to dwell upon the points of resemblance between nerve current and electricity (see "Muscles and Nerves," Dr. Rosenthal, International Series; Kegan Paul). But the fact must not be passed by that there is a special physical condition of the brain corresponding with every thought of which we are conscious. During every sustained thought nerve current is acting in a peculiar way in the brain, and probably affecting nerve current in the hand and over the whole body. I see a man standing on the

weathercock of a tall spire, and my knees knock together. This affection of the nerves, controlling the muscles of the knee, is not dependent on volition; therefore it may be regarded as a constant fact that a brain condition affects, with greater or less intensity, the nerves over the whole of the body. Here arises what is perhaps the critical question of the whole enquiry.

B is conscious of a thought: simultaneously he has in his brain the physical counterpart of his thought. Is it possible for that physical counterpart to be communicated to another individual, independently of impressions made through the senses? We have now advanced a stage. We have left the metaphysical region of thought, and have turned our attention to its physical counterpart in the brain.

When I say the counterpart of a thought I mean a corresponding physical molecular condition in the brain. If B see a peacock, the image of the bird gets no further than the retina of his eye. Anything less like a peacock than its molecular counterpart in his brain can hardly be conceived. If, in the absence of the bird, B voluntarily think of a peacock, the respective physical counterparts, of the sight impression and of the voluntary thought, will be identical, or sufficiently alike to be identified. If, now, the counterpart in the brain of B can be reproduced in the brain of A, A will think of a peacock, and so solve the problem of thought reading. I will now quote some words of Dr. Carpenter ("Mental Physiology," 6th edition, p. 633):—

"Looking at nerve force as a special form of physical energy, it may be deemed not altogether incredible that it should exert itself from a distance so as to bring the brain into direct dynamical communication with that of another, without the intermediation either of verbal language or of movements of expression."

Omitting much I would like to add here, I would say that, to use Dr. Carpenter's term, the dynamics of B's brain, when he is charged to concentrate his whole mind and keep it fixed on a single thought, must, I should suppose, be in a condition very favourable to observation. This kind of concentration is hard work, and, if prolonged, may be felt to the tips of the fingers.

Reverting to the remarkable resemblance between nerve current and electricity, it seems highly probable that nerve current can act at a distance. The phenomena of induction in electricity are too well known to require more than an allusion. Action at a distance may perhaps be said to be

the grand distinctive feature of electricity, dividing it from heat and light, which act not, except through their proper media. Nerve current being a force bearing a wondrous resemblance to electricity, will there be no analogous phenomena of action at a distance in nerve current?

What is the nature of nerve current? We know not; neither, according to Professor Tait, do we know the nature of electricity.

A wishes to know the thought of B; how does he place his own nerve current in relation with that of B?

The respective sensoria of A and B are not brought into juxtaposition, because externally the skull is not sensitive. Operators and subjects have sometimes been charged with laying their heads together: in such cases thought reading is of course metaphorical.

There are reasons why the hand should be used as the instrument for receiving the influence of the nerve current. It is extremely sensitive; but, above all, the brain is well accustomed to acts of discrimination founded on nerve current coming from the hand. A, we may suppose, is blindfolded. Touch any other part of his body with a hazel nut, he is doubtful; let it be brought into contact with his hand, he is sure. This is a sense of impression. True, but the brain is accustomed to judge what a thing *is* that sends up a message from the hand. The nerve current from the hand goes straight to the thalamus. No light is thrown upon the matter there. So the thalamus sends off the current, like a brush, to the grey cortex of the brain, where the current set up by the little hazel-nut is judged: not round enough for a marble; not heavy enough for a bullet; too hard for a little worsted ball; and so forth, till the conclusion is reached: it is a hazel-nut: down comes a message to the striated body, to be delivered to the organs of voice—say aloud, "It is a hazel-nut." Such is the ordinary course of a sense impression from the hand.

Let us now dispense altogether with the presence of the tangible object, and suppose that instead of being excited by the touch of a hazel-nut, the nerves in the hand of A are excited by the nerve current in the hand of B whilst he is thinking of a hazel-nut. A's hand will send a nerve message to his brain. Of what kind? Of no kind in particular? Quite incredible. What should particularise it? Its efficient cause, namely, B s nerve current, generated by a brain the physical condition of which corresponds with the thought of a hazel-nut. It seems to me highly probable that A would become more or less vividly conscious of an

action in his brain, which he would be able to interpret as having its source in the thought of a hazel-nut.

The consideration of the second constituent in thought reading—the abnormal exaltation of sensitiveness in the operator, A—must not detain us beyond the time required for a brief allusion to the several stages leading by a perfectly natural gradation to the most highly exalted condition of receptivity. All our examples will be found to illustrate the amazingly extended principle of *compensation* in Nature. Take the case of a man born blind or deaf. The absence of a sense damages the integrity of his intellectual power: in spite of which the blind man often has his power of hearing wonderfully acute, and the deaf man often has unusually clear vision. Let us pass on to the ordinary condition of sleep. In sleep sense impressions are all suspended; reason, judgment, and even volition, are in abeyance; yet in sleep we become conscious of that delicate process which is ever going on, day and night, and which, when we are awake, *is* unconscious cerebration, or the phosphorescent action of the brain. It is unperceived during the day whilst the senses are active, being overpowered by their stronger impressions, just as the light of the stars is unseen in the clear daylight. The action of unconscious cerebration may sometimes be detected if we are suddenly aroused just at the first commencement of a doze. It is very delicious, and its interruption is exceedingly irritating. In sleep it passes into dreaming, which may or may not be agreeable. In the state of reverie the train of thought is more coherent, the senses are not wholly paralysed, we see figures in the fire, and the likeness of a whale in the cloud, or something else; but volition is wanting. In somnambulism volition is active; the senses also are in a normal condition; but reason and judgment are suspended, and the sleep-walker crosses a chasm by a narrow plank, heedless of the consequences of a fall, or works a sum in arithmetic vainly attempted during the distractions of waking hours.

All these states are perfectly natural: we attribute them to no mysterious agency; and though the parcelling out of the reason, the will, the imagination, the judgment,—now one and now another of these being suspended,—is very surprising, yet not more so than the phenomena in insanity. Yet sleep, reverie, somnambulism, and catalepsy lead up so closely to the hypnotised and mesmerised conditions that why the one class of affections should be less a subject for scientific investigation than the other does not appear.

XUM

The subjection of the will to the influence of a ruling thought is the great feature in all these abnormal conditions: it is often attended by extreme sensitiveness towards everything in connection with the ruling thought. The will is suspended in the subject, and the operator vehemently impresses a ruling thought on his helpless victim. All of us have seen the result a hundred times: I never can see it without a shudder.

Permit me now, in conclusion, to apply these considerations to the phenomena of thought reading recently exhibited in Liverpool, speaking of the operator, Mr. Irving Bishop, as A, and his subject as B. A wishes to show that he can read the thought of B. As far as possible A changes place with B. A becomes the subject, and will have B for his operator. A first secures that B shall have, for the occasion, a ruling thought, *e.g.*, the spot where he has hid the pin. B is to concentrate and maintain his thought on this one thing. As soon as A has made this provision, A throws off his own will by hypnotising himself. A becomes the helpless subject, and B with his ruling thought the strong operator. A knows that B *has* a ruling thought, but A has yet to find out what it is. A therefore puts himself in *quasi* electric communication with B, by means of the hand or the wire; but not with B's ruling thought, which is totally out of A's reach, but with its physical counterpart in B's brain. The two brains become like two electric clock dials.

Considering the nerve energy due to a ruling thought in B, and the utter inability to resist in a hypnotised subject, such as A has become, it might be expected that A would not only act in accordance with B's thought, but that, so soon as he knew it, A would be in very great hurry to do so, would be very much exhausted after it, and would probably, on returning to himself, be quite forgetful of it.

Before bringing my remarks to a close I may refer to the thousands of experiments in thought reading, or, rather, brain reading, which are now from time to time occurring in private drawing-rooms throughout the country. Most of these experiments have been attended with partial success. Indeed, considering the very rough and deficient way in which these extremely delicate experiments have been conducted, the amount of success I have myself witnessed I regard as surprising. The nerve counterpart in the brain, the foundation of the whole process, can hardly have been sharply defined. A very slight approach to the sensitiveness

of the hypnotic state is all that can be attained by being blindfolded, though the thought reader is undoubtedly much indebted to the assiduity of gentlemen anxious to secure the complete bandaging of the eyes,—a zeal at which Mr. Bishop must often have smiled. Nevertheless the guesses of the most unprofessional thought readers have led again and again to the often-repeated expression "There must be something in it."

The foregoing remarks have no claim to be regarded as demonstrative, or anything more than hypothetical and suggestive. The physiologist will point out in them assumptions unproved, and perhaps incapable of proof. The materialist will assert that my "brain counterpart" of thought *is* thought, and will assure me that to speak of thought as anything beyond molecular action is extremely dangerous, mischievous, and ignorant.

One thing let me earnestly disclaim. I have no pretension to dissipate the mystery in thought reading. Only its real mystery is not superficial, a mere nine days' wonder, but a part of the profound mystery of life,—a mystery for Science, as the ages run, deeply and more deeply to explore, but not to fathom. It is *because it is natural* that it is admirable and wonderful, and that we may have a reasonable hope that, in time to come, it may prove to be of great value in the benevolent and Christian science of Mental Therapeutics.

VI. ON TECHNICAL EDUCATION.

By Robert Galloway, M.R.I.A.

(Continued from page 288.)

BEFORE continuing further our examination of the system of science teaching that has to be adopted in the Elementary Science Schools and Classes under the Department of Science and Art, and the examination and payment on result systems in operation, we will briefly explain what we mean by the

terms—*information*, *knowledge*, and *science*, as much confusion of thought prevails amongst the public in general, with respect to the meaning of these and other terms which have to be employed in discussing education questions.

The accumulation of stray particulars by means of the memory we term information; in every stage of life we are constantly acquiring information; but it is the predominating mental process that is in operation in childhood, and amongst the uncivilised and uneducated.

When *information* has been appropriated by us and thoroughly matured; in other words, when it has become a part of our own intelligence, or, to use Mr. Herbert Spencer's expression, when it has been turned into *faculty*; when, in short, we can reason about it and make use of it, we designate it knowledge.

Every human being, the uneducated, as well as the educated, reasons; but the uneducated reasons only about particulars, from like to like; he cannot, like the educated, discover that what is true of one thing is equally true of many other things; he is not, in fact, able, except in very simple cases, to generalise,—that is, draw a general law from particular cases; and it is by generalisation that the laws of *Nature* are learned from observation and experiment. Every human being before the time of Newton had observed that heavy bodies fall to the earth; but that great Philosopher reasoned on the fact, and the result of his reasoning led him to discover the Law of Gravity, and that this law governs, not alone Mundane matter, but that of other worlds. "General reasonings," states Hume, "seem intricate merely because they are general; nor is it easy for the bulk of mankind to distinguish, in a great number of particulars, that common circumstance in which they all agree, or to extract it pure and unmixed from other superfluous circumstances. Every judgment or conclusion with them is particular. They cannot enlarge their view to those universal propositions which comprehend under them an infinite number of individuals, and include a whole science in a single theorem. Their eye is confounded with such an extensive prospect; and the conclusions derived from it, even though clearly expressed, seem intricate and obscure."

The kind of education that prevails in most of our schools and colleges consists in crowding into the minds of the learners, unconnected—and therefore unprolific—facts and particulars. Education, too, generally begins and ends here in this land of educational endowments; for anyone can

become or be appointed a teacher; seldom has he to produce the requisite credentials that he has even *exact* knowledge of the subject he has to teach, and he is never required to prove that he has the power or faculty for training the mind; and yet it is only those who have that faculty who can rightly train and educate each individual mind so that the reasoning-power is expanded by causing the information acquired to be converted into knowledge.

When knowledge extends to a methodical comprehension of general laws and principles, it is called *science*; this is the highest stage of mental development, and many minds are unable to reach it; the many being apparently incapable of being cultured beyond a particular point. This is especially the case with the inferior human races. Mr. Herbert Spencer has in his first volume ("The Principles of Psychology") collected together a series of most interesting examples on this most important and interesting subject.

From what has been stated it will be apparent to all that the method the teacher adopts for imparting information is of the highest importance, more important for training and expanding the mind of the learner than the kind of information conveyed. If the wrong method is adopted—wrong because it does not correspond with the order of the unfolding of the mental faculties—the mind of the taught revolts; but if the right method is adopted, the taught—especially the young—delight in acquiring knowledge. One fundamental principle in all sound teaching is to commence with some particular the learner knows or can readily comprehend, and so ascend, from the simple to the complex, by a series of easy and natural gradations, to what at the commencement the learner did not know; so that he becomes, as it were, his own instructor, as he discovers apparently of himself the knowledge conveyed. This is the reason why children delight in picking up information themselves, but are *stupid*, *drowsy*, and *sulky*, in school, if the mechanical routine system of teaching prevails. The late Dr. John Brown in the article "Education through the Senses," in his work "Horæ Subsecivæ," humorously describes the difference in feeling children exhibit in acquiring information themselves, with that which they exhibit in a school where the mind is tortured by the system of teaching adopted. The superiority of Pestalozzi's system and Frobel's Kindergarten method of education over all other systems for teaching children is due in my opinion to the fact that they have systematised the method children themselves adopt in acquiring information. In the Platonic dialogue where

Socrates undertakes to show his friend that his boy servant or slave knew Geometry, Socrates commences with the figure of a square which the boy knew, and he proceeds in such a natural order that the boy discovered, by his own unaided efforts, as it were, what he had not known before.

The change the learner displays for acquiring knowledge is marvellous, if a rational method of teaching a subject—a method in accordance with the laws of mental development—is substituted for a mechanical routine system; the apathy and disgust for learning he had before shown is replaced by the greatest earnestness and delight. I have been a witness of many cases of the kind; but the one which most impressed me I will briefly relate:—Many years ago I accepted the post of teacher of Chemistry at Queenwood College, Hampshire; the College at that time comprised a boys' school and an Agricultural College; the Agricultural pupils were all young men; most of the boys as well as the young men were instructed in chemical analysis in the laboratory attached to the Institution. When I entered upon my duties, I found the book in use was the "Giessen Outlines," and, to my surprise and discouragement, both the young men and boys exhibited a thorough disgust for Chemistry as a study: the young men would not, with the exception of one or two, attend the classes on this subject, and the boys only attended their's under compulsion. Most of them could analyse *complicated* mixtures pretty accurately; but they did not know why and the wherefore; they simply made the analyses as directed by the tables in the book. They explained to me why they disliked the subject; they said, "we can make the analyses, but we do not understand what we are doing, and therefore we do not like the study." After much thought upon the matter, I drew up some analytical tables myself, which I afterwards published, which overcame all the difficulties, and turned a study which had hitherto caused disgust into a great source of pleasure to *both* classes of students: not one of them would be willingly absent from class after the change in the method of teaching the subject had been made. The tables were framed in accordance with the laws of mental evolution; they are so constructed that the learner has to exercise the faculty of judgment or comparison (perception of difference or agreement), which philosophers of all schools agree in placing amongst the original powers of the human being. The system compels the pupil himself to *Compare, Distinguish, Judge;* he therefore becomes an intelligent and active *Discoverer*, for he discovers, himself, the methods for separating and detecting the different

members in each group of substances, and so throughout the entire analytical course. But my plan possesses other important advantages over every other which has yet been proposed. It exhibits a like progression to the mind; it begins with a few subjects, and successively adds to them until the entire analytical course is reached; it proceeds, in short, from the simple to the complex.

Those who seek to reform and improve any established system like the one under discussion have generally to deal with two classes of *obstructives:* the more formidable class consists of those who are pecuniarily interested in preventing any change; the other class consists of those who are only superficially acquainted with the subject: those composing the latter class generally cite authority in support of their views, and they are not unfrequently made use of under this veil of authority by the former class in opposing all real reform. Now as written examinations form the chief, if not the sole, tests for estimating the students' attainments in the Inductive Sciences at our different Universities, these apparently high authorities in *all* educational matters may be adduced in opposition to my views of the subject: it may be well therefore to inform the second class of opponents that only such branches of study were examined upon whose written examinations were first established at our Universities. As the examinee could do or put in practice at the examination just as he would in any future employment in the actual business of life, what were termed mere *information* subjects—which do not, like the former, admit of *direct measurement*—were excluded, and it was long before they were admitted as examination subjects. Pen, ink, and paper are the instruments, in addition to books, which students of languages and the Deductive Sciences require for the prosecution of their studies in these subjects; but pen, ink, and paper, as well as books, are only subsidiary instruments in the cultivation of the Inductive Sciences: to acquire a knowledge of these sciences the student must not only know what has been done by others, but he must himself study the productions and operations of Nature in the laboratory or in the field; and it is there only he can be efficiently examined, for it is there only that it can be ascertained whether he has acquired a knowledge of things or only the names of things. This examination system, even at our Universities, is destructive of good teaching; the Professor is apt to depend more for obtaining a class by getting his subject to be one examined upon than attracting them by good teaching, and the students, I was informed

some years ago by a Professor of Chemistry at one of the Colleges at Cambridge, will only learn what will pass them; they cannot be induced to stray beyond the limits of probable questions; the training they receive, according to the Rector of Lincoln College, Oxford, is not training in investigation, in research, in scientific procedure, *but in the art of producing a clever answer to a question on a subject of which they have no real knowledge.*

Written examinations, however perfectly the questions may be framed, cannot be made efficient and practical tests for any of the Inductive Sciences, whether experimental or observational; but, as long as they are employed as tests, the questions given ought chiefly to be of the kind that would test as completely as possible whether the examinee had acquired a *knowledge* of his subject or whether what he had acquired was mere information. *Knowledge questions,** as I will term them, are rarely given in examination papers on Chemistry; the questions generally relate to particular facts, and are therefore mere information questions; and it is this class of questions that are chiefly given at the Department's examinations. Indeed the practical difficulties of awarding marks *equally* and fairly to such a large number of students, if questions were given which would test as efficiently as possible whether the examinees had been trained in learning the science, to reason, and think, themselves, on what they were taught, would be almost impossible; because many of the questions would only be answered in part by the majority. The examiner would, therefore, before he got through all the papers, have become so utterly wearied as to the number of marks he ought to assign to each of the numerous answers to each of the different questions, that his faculty of judgment and comparison would be lost long before he had completed his task. Nor are the difficulties overcome by distributing the papers amongst several examiners. Indeed, another difficulty then arises, for, for questions of this kind, the standard of the different examiners would vary, and, as the teachers are paid on the result system, they would receive unequal payment, on account of the difference in the standards of the examiners. I am afraid, also, if such questions were set, some of the assistant examiners, who are paid so much per dozen papers they examine, would perform their task in a more perfunctory manner than they are considered to do at present; for it

* I have given examples of what I term Knowledge Questions in my work "Education, Scientific and Technical," in the chapter on Examinations and Examiners.

has been observed that it is not always in the study of the examiner that these papers are looked over and the marks assigned, but that they are sometimes examined in such unsuitable places as Railway Carriages, Examination Rooms, &c. I am afraid the poor science teachers sometimes suffer pecuniarily from such slapdash examinations, conducted at odd times, of their pupils' papers.

I will give an example to show how differently two examiners will examine and mark, even in a comparatively small chemical class; and therefore it shows how uncertain it must be as to what science teachers who are paid on the result system will earn, as it must vary with the examiner who happens to examine the pupils' papers; and it shows, further, that confusion and discrepancies would still more prevail if knowledge questions were largely employed. And it clearly shows that on account of the uncertainty of the amount of payment to be received, it will prevent some of the most competent from becoming teachers under this system.

The two examiners I will distinguish by the letters A and B; A is one of the professional examiners, and B I believe is one of the assistant examiners. The class examined was not one in the elementary science schools, but in a college of science. Examiner A does not belong to the college, but is appointed by the authorities to set a paper and examine the answers given; B is the teacher in the college—he also sets a paper and examines the answers to that paper. The examination of which I give the results was held about eighteen months ago, but a more recent examination by the same parties in the same college would show similar discrepancies in the marks assigned by the two examiners.

It is perfectly evident from the discrepancies in the marks assigned to most of the students, that, either examiner A thought the students ought to have had a better acquaintance with the subject than the results of his examination proved they had, or the two examiners adopted a very different system of marking, as B in not one single instance marked below A, but in every case above him. The teacher did not lose any payment by the discrepancies, as he is not paid on the result system; but it would have made a material difference to one paid on the result system whether A or B's marks were adopted; for A's marks amount on the average to 40·5, whilst the average of B's marks amount to 69·6; or for every 100 marks given by A 171·85 were given by B.

I give numbers in place of the names of the students :—

	A's Marks.	B's Marks.
	Total Number of Marks 100.	
1.	92·5	96
2.	71·7	94
3.	71·1	86
4.	64·7	97
5.	64·7	90
6.	61·0	88
7.	57·7	89
8.	50·3	89
9.	43·8	75
10.	36·9	50
11.	35·8	65
12.	34·8	63
13.	34·2	91
14.	32·1	83
15.	25·7	71
16.	23·5	30
17.	23·0	47
18.	18·7	71
19.	15·5	49
20.	13·9	59
21.	12·3	30
22.	8·0	18

(To be continued.)

ANALYSES OF BOOKS.

Physiological Cruelty or Fact v. *Fancy: An Enquiry into the Vivisection Question.* By PHILANTHROPOS. London: Tinsley Brothers.

SECOND NOTICE (see p. 354).

PHILANTHROPOS says, in meeting Mr. Hutton's contention, "We must try, then, to imagine ourselves belonging to superior beings who make us obey them in all things, and whose reasons we can seldom understand. They tie us up in order to prevent our going where they wish—they prevent our making love, for fear of its interfering with our work—they keep us in prisons, because they like to look at us and to hear us sing—they take away our clothes, in order to wear them themselves—they crop our ears, because they think we look prettier with them short—they do various painful things to us in order to make us taste nicer when cooked—and, finally, they kill and eat us. . . . If we were suddenly enabled to understand the reasons for each action, our dispositions remaining the same, is it likely that the sense of injury which had not been evoked by anything else would arise when they went on to use us for experiments for the advancement of their science and the improvement of their own health?"

In the next chapter the author puts the much-needed question "What is vivisection?" On this subject the vaguest notions prevail, not merely among the public, but among Bestiarian advocates, who, if better informed themselves, have no objection to profit by vulgar confusion and exaggeration. Philanthropos shows how little—vanishingly little—of the work performed in a physiological laboratory can in any manner be included under this name. He shows that "in England animals are never dissected alive in order to show the relations of their parts. . . . There is no room for talking about medical students being demoralised by witnessing tortures: there are none for them to witness." Painful operations are confined to purposes of original research, and "in the few cases where pain must be given it is generally very slight." The author enumerates inoculations, used in studying the origin and communication of disease, experiments on the effects of drugs, and especially the treatment of poisons; and, lastly, a few experiments relating to various animal functions. In this latter class anæsthetics were used, wherever possible, before any law was passed on the subject. Here Philanthropos truly says—"Yet although no fact is better

authenticated than this systematic narcotising of creatures experimented on, it is quietly and constantly ignored; vivisection is described (by Miss Cobbe) as the 'worst form of cruelty we know,' and the words 'agony,' 'torture,' and 'torment' are scattered about as if no such things existed as chloroform, ether, and morphia." The number of experiments in which pain—not even apparently great—was produced during the years 1878, 1879, and 1880, amounted, according to the official report, to less than 100! Truly a drop in the bucket compared with the sufferings of animals in other causes than the pursuit of knowledge!

In the sixth chapter the author explains the necessity of experiment to physiology. From this chapter, which we strongly recommend to the careful study of our non-medical—or, more widely speaking, non-biological—readers, we can merely quote the following pregnant passage:—"Those who defend physiological experiment as an absolute necessity to medicine do so—not because this or that drug has been discovered by its means, this or that operation perfected through its practice. They defend it, because without it medicine is based upon ignorance, and every doctor is a charlatan patching at a wonderful mechanism of which he knows nothing. They defend it, because it is the foundation upon which physiology as a science stands. The pseudo-sciences rest upon theorising, guess-work, and empiricism; a true science rests upon experiment. If physiology be deprived of this necessary foundation it will be degraded through no fault of its disciples; it will not fall to pieces, because that which has been won cannot be taken away, but it will be unable to encroach any further upon the morass of human ignorance, because forbidden to lay a firm footing for its advancing tread. But, after all, interests differ. There are some who do not care for that morass to be invaded. 'Quand on veut dessêcher un marais, on ne fait pas voter les grenouilles.'" In England, unfortunately, we allow the frogs to vote, and they croak loudly enough, in Parliament, in public meetings, and in the pages of certain of our contemporaries.

In the last chapter of his book the author discusses the legislation on the subject—past, present, and possible. Concerning such legislation he writes:—"It is very curious and interesting, and has the great merit of being peculiarly British. That is to say, it is not trammelled by any principle previously laid down or hindered by any consideration of reasoning or consistency. To found a new law upon a distinct principle, from which its enactments develop logically, has a Continental flavour about it displeasing to the national mind, and reminds us in some way of centralisation.* We prefer to make a fresh regulation every now and then, when somebody makes a fuss and it is necessary to do

* In one sphere at least we submit humbly enough to the sway of a centralising bureaucracy.

something." The existing law is well summed up in the following words:—"It is penal to use domestic animals in any way cruelly, but anyone may torture wild creatures in whatever fashion he likes, provided it be not for scientific purposes. Nothing makes it criminal to give pain to a wild animal *except* having sufficient justification."

We find next a very clear and fair history of the rise and progress of the Bestiarian agitation. We find especial mention of the fact that, in spite of the aid of Detectives, the Society for the Prevention of Cruelty to Animals was utterly unable to find anything to warrant legal proceedings against a physiological experimentalist up to the abortive Norwich proceedings. Funds were there in abundance; there was espionage, vigour, and a hostile animus, but there was nothing to detect!

We come now to the Royal Commission of Inquiry appointed in June, 1875. To this step the medical profession and the scientific world generally offered no objection. The composition of the Commission was somewhat curious. It comprised three politicians (Viscount Cardwell, Baron Winmarleigh, and the Right Hon. W. E. Forster), a lawyer (Sir J. B. Karslake), two men of Science (Prof. Huxley and Mr. Erichsen), and a journalist (Mr. Hutton, of the "Spectator"). On what principle the last-named gentleman was selected in preference to any other of the thirty and odd millions of inhabitants of the United Kingdom we are not aware. He seems to have, throughout the inquiry, played the part of examining counsel for the Bestiarians. But though he signed the Report of the Commission in which the necessity of physiological experimentation is admitted, he has found it not contrary to his notions of consistency to persist in the agitation. Mr. Jesse, we understand, goes the length of accusing the Commissioners of suppressing evidence brought before them, which is certainly an ungrateful return for Mr. Hutton's advocacy. It has been truthfully said that in this celebrated inquiry the evidence went beyond the facts, the report beyond the evidence, and the subsequent legislation beyond the report. The Right Hon. Robert Lowe (now Lord Sherbrooke) pronounced the proceeding of the Commissioners "very singular. They acquitted the accused, and sentenced them to be under the surveillance of the police for life." It is hinted in certain quarters that both the appointment of the Commission and the legislation which followed are at least indirectly due to the influence of a most exalted Personage. If so we would, with all deference, suggest that her dislike to cruelty might have been more fittingly displayed in the suppression of the Royal buck-hounds and their performances.

The heads of the "Anti-Vivisection Act" of 1876 are here given. It is shown, as an objectionable feature, and as a departure from the Recommendations of the Commission, that the Home Secretary is in practice invested with the arbitrary and

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irresponsible power of deciding whether, and under what conditions, certificates and licenses under the Act are to be granted. In consequence the "Medical Dictator has prevented researches into antidotes to snake-poisons, the multiplication of septic organisms, the physiology of the brain, the functions of the spleen, the method of renal secretion, aseptic dressing of wounds, the actions of certain poisons, intestinal secretions and movements, ligatures on arteries, and other matters. Men are left to die of poison, wounds, and disease, for want of the knowledge that can only be obtained at the expense of animals. . . . Dr. Brunton has been forbidden to seek for antidotes to snake-bites, Professor Fraser has been checked in his attempts to study the nature of the poison used by the natives of Borneo upon their arrows, while Prof. Lister has had to leave England in order to carry on his researches. And besides the list of stifled investigations already given, how many more are left unattempted because of the difficulties thrown in the way? Surely this state of things is not creditable, and ought not to endure." The author, as we have already intimated, takes an exceedingly moderate ground. He does not, like ourselves, demand the repeal of the Act of 1876, but would be content with its administration in a spirit less unfavourable to Science than has hitherto prevailed. He merely wishes the Home Secretary to be guided by the "competent advisers" whom the Act provides.

We hope that this work will receive the wide and careful study which it merits, and that its accurate truth and sound reasoning may prove an antidote to the sophistical and fanatic eloquence of Bestiarian speakers and writers.

The Natural Genesis. By GERALD MASSEY. Vol. I.

WE have here the first volume of a bulky work, the importance of which is fully proportionate to its extent. Our readers will perceive that we give no publisher's name. Our excuse must be that none is given in the copy which has been forwarded to us. We can merely give the address of the printers: R. Clay, Sons, and Taylor, Bread Street Hill, Queen Victoria Street, E.C.

But what is the subject of the book? Mr. Massey is an independent thinker, a heretic. After prolonged and laborious enquiry he rejects certain modern theories as to the origin of civilisation and the formation of language. He is no believer in the "Aryan hypothesis." He contends that the transition from the bestial to the lowest human condition took place not in Central Asia or Northern India, but in the interior of Africa, and that the stream of culture flowed along the Valley of the Nile. He shows that

language is derived not from abstract roots, but from signs and symbolic actions far antecedent. He does away with the notions of a civilisation springing up suddenly or miraculously communicated to man, and of a language rich and complete in its very origin. For the first time, perhaps, we have inquires into primitive philology, mythology, and the early history of our species untainted by the preconceived notion of an absolute and qualitative distinction between man and the lower animals. The author's results are in strict accord with those which modern naturalists have reached by totally different processes. We do not hesitate to say that if the substance of this work could be presented in a condensed form, freed as much as possible from "scaffolding," it would form a valuable—almost necessary—companion to Darwin's "Descent of Man," the one work complementing and supporting the other.

We must, however, remark that much remains to be done before Mr. Massey's labours can be presented in such a form. At present there is neither title-page, index, table of contents, preface, nor introductory chapter. Only the leisurely and conscientious reader, or the candid reviewer, will succeed in fairly grasping Mr. Massey's current of thought; this the rather because the conclusions reached will be, to many, grievously unwelcome.

We find here successively discussed the natural genesis of the Kamite typology, the typology of primitive customs, the typology of the two truths, the typology of numbers, the typology of primordial onomatopœia and aboriginal African sounds, the typology of the mythical serpent or dragon, the typology of the mythical mount, the tree, the cross, and the four corners, and the typology of the mythical great mother, the two sisters, the twins, the triads, trinity, and tetrad.

As a specimen of the author's method of conducting this great inquiry we make certain extracts from the chapter on the typology of onomatopœia. Mr. Massey writes:—"The Aryanists have laboured to set the great pyramid of language on its apex in Asia instead of on its base in Africa, where we have now to seek for the veriest beginnings. My appeal is made to anthropologists, ethnologists, and evolutionists, not to mere philologists limited to the Aryan area, who, as non-evolutionists, have laid fast hold at the wrong end of things.

"The Inner African languages prove that words had earlier forms than those which have become the 'roots' of the Aryanists. Max Müller has said that in the Sanskrit word *Asu*, which denotes the vital breath, the original meaning of the root '*As*' has been preserved." He writes:—"*As*, in order to give rise to such a noun as *asu*, must have meant to breathe; then to live; then to exist; and it must have passed through all these stages before it could have been used as the abstract auxiliary verb which we find not only in Sanskrit, but in all the Aryan languages. Unless this one derivative, *Asu*, life, had been preserved

in Sanskrit, it would have been impossible to guess the original material meaning of the root *As*, to be." Mr. Massey replies: —"The African languages show that *asu*, to breathe, is *not a primary of speech*; no vowel is *primary in the earliest formation of words*. In Egyptian *ses* is to breathe, and in Africa beyond: *zuzu* has the same meaning in the Nupe, Esitako, Gugu Basa tongues; *zuezui* in the Param, *yisie* in the Kupa, and *zo* in the Ebe."

He continues—"It has been asked how did *Da* (Sanskrit) come to mean giving? Professor Noiré holds that primitive man said *accidentally Da*. And here we have a 'root' of language! But *da* is only a worn-down form of word found in Sanskrit. It is the Egyptian *Tâ*, to give and take, and also a gift. The full hierogylyphic word is *Tat*, and it belongs to the stage of mere duplicated words and gesture-signs. It is written as the hand, which is the Tat ideograph; English *daddle* for the fist, *ntata* for the hand in the Meto and Matatan, and *tata* in the Igu tongue. Long before the abstract idea of giving was conveyed by *da* or *tâ*, the *tat* was *presented* in gesture-language with the offering, or in the act of offering. . . . Language certainly did not originate with the 'roots' of the Aryanists, which are the worn-down forms of earlier words. It did not begin with 'abstract roots,' nor with dictionary words at all, but with things, objects, gesture-signs, and involuntary sounds." We may here remark that the very term "root" conveys an analogy fatal to its advocates. The plant does not originate with the root, but with the seed, and puts out the root subsequently.

Elsewhere, as a further explanation of his meaning, the author says:—"That which we can *talk*, *say*, and *write* was first *enacted*, and the most primitive customs were the sole *records* of such acting by men who *performed* those things that could not otherwise have been memorised. These customs had their origin in gesture-language; they constitute the drama of dumb humanity, and volumes might be filled in showing the (to us) unnatural-looking results of an origin that was quite natural."

The following passage refers to a recent blunder into which philologists tumbled blindly:—"Comparative philology, working with words in their later phase, divorced from *things* is responsible for the false inference that until recent times, later than those of the Veda, the Avesta, the Hebrew, and Homeric writings, men were deficient in the perception of colour; that there was, in fact, a condition of Miopœia answering to their insanity of Mythopœia. Geiger has even affirmed that the language-maker must have been blue-blind. Max Müller has affirmed that the blue heaven does not appear in the Vedas, the Avesta, or the Old Testament. It is true that language did not commence by naming those mere appearances of things in which the comparative mythologists take such inordinate delight. Many early languages have no word for blue as a colour, and

yet blue as a thing may be found in them." Thus the Egyptian name for blue is *khesbet*, *i.e.*, lazulite. It may in one sense be considered a digression, but we cannot help pointing out the utterly fallacious character of the inference that because a certain race of men had no distinct, definite word for a colour, they were therefore incapable of distinguishing such colour. We find that insects recognise and remember colours. Are we to suppose that they have, therefore, a nomenclature for colours? We highly specialised men of civilised Europe and America can distinguish and carry in our memory hundreds of odours, pleasant or offensive. Yet our names for them are few indeed, and so vague and indefinite, that we once heard a man speak of a "heavy sweet smell, like dung." He was not joking. It is much the same with flavours. Here, also, Mr. Massey very justly says—"Power of perceiving qualities and distinguishing things does not depend on the possession of words to express shades of difference. Sweet could be distinguished from bitter when the one was only expressed by the mouth watering and a smack of gustativeness; the other by spitting, with the accompaniment of an interjection of repugnance. . . . The early men thought in things and images where we think in words, or think we think." Leibnitz said that the writing of the Chinese might seem to have been invented by a deaf person, its formation being so near to that of gesture-signs addressed to the eye. The oldest Chinese characters, two hundred in number, are called *Siang-Hing*,—that is, images or ideographic representations. Elsewhere the author remarks—"Verbs would be first *enacted* before they were uttered in what we could recognise as speech. A pair of feet Going is the sign of the verb to Go, and Going pourtrayed in several forms preceded any abstract verb for to Go."

Turning reluctantly from the section on the typology of language, which must ultimately give comparative philology a new departure and a more rational character, we briefly glance at the author's labours in other, though kindred, directions. In his exposition of the genesis of the Kamite typology, Mr. Massey says that the unwritten, esoteric teaching of the Gnosis, the Kabalah, the inner mysteries, was concealed, not on account of its profundity, but because of its primitiveness. "It is not the ancient legends that lie; the creators of these did not deal falsely with us. The falsehood is solely the result of ignorantly mistaking mythology for revelation and historical truth. They did not teach geology in the ancient mysteries. The Christian world assumed that they did, and therefore it was found in opposition to scientific geology."

The following passage is very significant:—"The religious ritual of the moderns is crowded like a kitchen-midden with the refuse relics of customs that were once natural, and are now clung to as if they were supernatural in their efficacy, because their origin is unknown. Such customs are like those rudiment-

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ary organs of animals which Nature has suppressed and superseded, and which only tell of uses long since passed away."

Commenting on the custom of salutation by rubbing noses together, as common among not a few savage tribes, Mr. Massey reminds us that it "goes back to the animal mode of salutation by smelling." In this direction he has done good service in connecting the language and customs of animals with those of man.

Reluctantly breaking off our survey of this remarkable book, we can merely hope that what we have said may at least excite the curiosity of the reader, and lead him to inquire for himself. We would, indeed, bespeak for Mr. Massey's work the earnest attention of Evolutionists. To us it seems that he is turning the only position of importance still held by our opponents, and that his movement, if properly followed up, will be decisive.

A Manual of Photographic Chemistry, Theoretical and Practical. By Rev. T. Frederick Hardwick, M.A. Edited by J. Traill Taylor, Editor of the Photographic Times and American Photographer. London: J. and A. Churchill.

This work, having already reached its ninth edition, may be considered as having established itself in public favour. The present editor tells us that, since the appearance of former editions, two changes of importance have occurred. One of these appears to be the last revolution in chemical nomenclature; the other, of a practical nature, is the introduction of a gelatine emulsion in place of collodion. He accordingly uses in the work an approximation to the modern nomenclature, though remarking that it does not seem judicious entirely to discard the old. This caution is justified by the fact that manufacturers, drysalters, and persons practically engaged in the various chemical arts, still employ almost exclusively the language current in the second quarter of the present century. Perhaps, however, his best plan would have been to have placed the old names in brackets after the new ones, or inversely.

A few errors appear to have escaped the notice both of author and editor. Thus, under "Alum," we find the statement that "much of the common alum contains ammonia as well as potassium." There was at one time a great abundance of so-called ammonia-alum in the market in which ammonium took the place of potassium. But we never either heard of or met with a sample in which both these bodies were simultaneously present. Since the discovery of the Stassfurt saline deposits the salts of potash have

fallen in price, and are so exclusively used in alum-making that it is now not easy to procure a sample of ammonia alum.

Under "Castor Oil" we read that "this oil is extracted from the seeds of *Ricinus communis* or Palma Christi, both of which are cultivated in warm climates." Palma Christi is simply a synonym for *Ricinus communis*, not a distinct species of tree.

Under "Organic Matter" we find a curious remark:—"This term is often employed to designate varieties of non-volatile vegetable and animal substances of unknown composition, which are prone to change by absorption of oxygen. Bodies which have a definite formula, however, are often included in the class of organic matters if they readily pass by oxidation into ill-defined products. But a stable vegetable acid like acetic acid, or a neutral substance not readily oxidisable, such as glycerine, although really organic in composition, would not usually be referred to by this term." We certainly have never heard the term "organic matter" applied exclusively or preferentially to unstable bodies or such as are of indefinite or unknown composition. If such a usage exists, the author would have done well to have pointed out its impropriety.

On page 93 we read that "solutions of the sulphocyanides of ammonium or potassium have been recommended for fixing positive photographs instead of hyposulphite of soda; but it is doubtful whether any advantage is gained." But on page 149 it is stated that the sulphocyanides "have the advantage of imparting no sulphur to the print, and they preserve the tones clear and free from mealiness."

As regards the purely photographic or the practical portion of the book before us, there can be no doubt that it fully merits the reputation which it has all along enjoyed. In case of a new edition, which may be looked forward to as a matter of certainty, we should suggest a revision of the earlier or introductory chapters.

Transit Tables for 1883. Giving the Greenwich Mean Time of the Transit of the Sun and of certain Stars, for every Day in the Year; with an Ephemeris of the Sun, Moon, and Planets, and other Information, computed from the Nautical Almanac for Popular Use. By LATIMER CLARK, M.I.C.E., &c. London: A. J. Frost.

THIS work gives instructions in the art of obtaining correct time in any part of the world by means of the transit instrument. The Preface explains the use of this important astronomical instrument, and the method of its adjustment. For this purpose it is merely needful to choose an open site facing southwards, to

adjust the level, and point the telescope of the instrument as nearly to the true meridian as can be guessed. The time of passage of any two stars across the centre wire is then noted, selecting from the Tables in the book two which differ decidedly in their altitude. If both pass correctly to the time given in the Tables, the instrument is rightly fixed. If the lower star passes too soon, the transit instrument has been pointed to the east of the true meridian. If, on the contrary, the lower star passes too late, the conclusion is that the instrument is turned to the westward.

When once the adjustment is completed the correct local time may easily be found by noting the stars which pass the meridian and comparing their transit with the time given in the Tables. A correction is then made to find Greenwich time, accordingly as the place of observation lies to the east or west of Greenwich. The difference of longitude is converted into time at the rate of 4 minutes per degree and 4 seconds per minute of longitude. If the place of observation is westward of Greenwich this difference is added to the time given in the tables, but if it is situate eastwards it is subtracted.

The Tables show the transits of the sun, and of five of the principal stars for every day of the current year, and also the transits, altitude, and declination of a number of additional stars.

The second part of the book shows, for each day of the year, the rising and setting of the sun; the rising, transit, and setting of the moon; the sidereal time at mean noon; and the mean temperature at 9 a.m. The opposite page shows the rise, transit, and setting of Mercury, Venus, Mars, Jupiter, and Saturn for six days in each month, and their relative positions to the moon and to different constellations.

The work before us will aid in popularising astronomical observation.

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*From the Molecular World.** Heidelberg: Carl Winter.

THIS remarkable book appears without the name of the author, though to anyone acquainted with the modern chemical literature of Germany the secret of its origin will be exceedingly open. The author represents himself as on a visit to Naples, and as viewing with no small interest the Aquarium, which by the way —unlike certain establishments of the same name nearer home— is a genuine scientific institution, and not a place of assembly

* Aus der Molecular-Welt.

for "loose fish." Having inspected the wonders of the watery world he hears of an Aërarium where certain airy—not to say visionary—beings may be viewed. He enters, and looks through the glass sides of the different compartments. In one cell, near the entrance, he sees a tumultuous assemblage of tiny beings which are restlessly darting about in couples. Each of these beings has but one hand, with which it clasps the hand of its companion, and in this manner they move backwards and forwards at the rate of 1844 metres per second; and whilst each pair is thus engaged, each of its constituent members is turning round and round, advancing to or retreating from its partner. In another compartment we see similarly-constituted pairs of one-handed beings, in greenish yellow garb, and smelling not exactly of patchouli. They also belong to the party of progress, though, being much heavier than the last-described sprites, they move only at the rate of 310 metres per second. It is scarcely necessary to tell the names of these beings: the inmates of the first cell are atoms of hydrogen grouped in molecules, whilst the next den is inhabited by chlorine.

In a similar manner, and with a dry humour not to be preserved in any translation, the author figures the molecules of other elements and compounds. Watching a molecule of hydrogen chloride, he asks whether the members of this couple enjoy a permanent inward happiness in their union corresponding to the fire with which it was entered upon? "Of this we cannot feel so certain as might be desired; the couple looks desperately sour, and the humiliated hydrogen seems to think 'affinity, alas affinity, has brought me into a scrape.'"

Our author next discusses the question whether atoms of the same kind within the same molecule may claim equal or unequal rank? Which of these two views is orthodox? No one seems to have permanent authority to decide. Hence many compounds have had more constitutions, and consequently more revolutions, than France. For none of these theories can the author feel any enthusiasm, though he hopes that each may be, perhaps, a nearer approximation to the truth than were its predecessors. "Every, for the time being, modern doctrine in the territory of our science is merciless to former views which it is unable to assimilate, and pronounces them simply injurious.

The following passage is an excellent specimen of the author's line of thought:—"Do you recognise these ladies, each of whom is dancing so gracefully? That is the light Methylia; on her father's side of a good family,—pyrogenita, if not porphyrogenita,—but her mother is a wooden thing. Behind her we see Æthylia, and there is the heavy Amylia. We know them, and a number of their friends of similar character. In our young days they were known only by their fore-names,* and they were

* The sensible German term for what we absurdly call the "Christian name," though its bearer may be a Jew, a Buddhist, or an Islamite.

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recognised as belonging to a certain stamp of radicals. Latterly they have assumed the family name Alkyl, having, I believe, been induced to take this step in Würzburg. What kind of partners have they in this dance? These atom-groups, who evidently take pains to look proud and disagreeable. They are scarcely to be distinguished from each other. If we converse with these conceited beings, we hear each of them say, 'My name is Hydroxyl.' But we have a good memory for chemical features. They are the same who, under their old name Eurhyzen, were so publicly scorned by a French chemist—not appreciated until after his death—that, so to speak, the very dogs would not accept a piece of bread from them. But now, under the new name, they are beings of distinction in the molecular world."

The author wages war, as will be seen, against vague, baseless hypotheses, against "paper-science," and insists upon a firm foundation of facts. Hence his satire is not out of place in an age when undemonstrated and undemonstrable assumptions readily pave the way to a certain kind of reputation. All chemists,—and men of Science in general,—if sufficiently versed in the German language, will find this work suggestive.

The treatise is printed not in the German type, but in an unpleasant modification of the Latin character. Lest the reader should proceed with too great comfort, the long *s*, which has disappeared from use in England and France, is employed, except at the end of a word. For the compound letter *sz*, which many German printers discard in favour of *ss*, there has been invented a new letter, resembling a Greek *β*, which, like the fox in the fable, has lost his tail in a trap.

Notes on the Detection of the Acids usually met with in Analysis. By J. William James, Ph.D., F.C.S. London: J. and A. Churchill.

The author of this little Manual remarks, in his Preface, that though there are numbers of books on qualitative analysis in which the detection of the bases is ably explained, yet the acids have been relatively overlooked, at least as far as regards their detection when occurring in mixture. This deficiency it is his object to make good. The instructions given are clear and simple, and will doubtless prove useful to laboratory students.

Longman's Magazine. May, 1883.

In this issue we notice a pleasantly-written article entitled "An American's Impressions of some British Song-Birds." The writer, Mr. John Burroughs, is an able and enthusiastic observer of bird-life, and puts on record some points which our British ornithologists seem to have overlooked. He is particularly struck with the abundance and the eager vociferation of the chaffinch, or, as it is locally called, shilfa, flax-finch, flacky, or spink. He says "the most abundant song-bird in Britain is the chaffinch, the most conspicuous wild flower (in June at least) is the foxglove, and the most ubiquitous weed is the nettle." The first of these three assertions I fully admit; but as to the foxglove we could show Mr. Burroughs districts where it is entirely wanting.

The author writes:—"I could well understand, after being in England for a few days, why to English travellers our songsters seem inferior to their own. They are much less loud and vociferous, less abundant and familiar; one needs to woo them more; they are less recently out of the wilderness; their songs have the delicacy and wildness of most woodsey forms, and are as plaintive as the whistle of the wind. They are not so happy a race as the English songsters, as if life had more trials for them, as doubtless it has in their enforced migrations and in the severer climate with which they have to contend."

The comparative happiness of birds on either side of the Atlantic is a difficult question; but what with nest-robbing urchins, with bird-catchers, and town sportsmen,—three classes ever to be anathematised by the ornithologist,—our British songsters have but a hard life.

The following is a curious and interesting remark:—"I was soon struck with the fact that in the main the British song-birds lead up to and culminate in two species—namely, in the lark and the nightingale. In these two birds all that is characteristic in the other songsters is gathered up and carried to perfection. They crown the series. Nearly all the finches and pipits seem like rude studies and sketches of the sky-lark, and nearly all the warblers and thrushes point to the nightingale; their powers have fully blossomed in her. There is nothing in the lark's song, in the quality or in the manner of it, that is not sketched or suggested in some voice lower in the choir, and the tone and compass of the warblers mount in regular gradation from the clinking note of the chiffchaff up to the nightingale."

Mr. Burroughs gives a favourable estimate of the blackbird, the willow-warbler, the wren, and the robin. The wood-lark he sought in vain, and we have taken good care that he should not hear the golden oriole, which once was ours.

On hearing the European cuckoo he regrets that he had ever heard a cuckoo-clock. These devices, extremely rare in England,

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must be very common in America, since they cause the note of the bird to have "a second-hand, artificial sound."

Reading over this paper we are struck with an instance of the feebleness of the so-called Anglo-Saxon race in name-giving. There are in America birds, not a few, bearing the same popular names as certain European species, but totally distinct. Thus the American robin is a kind of thrush. They have a sparrow distinct from ours, though, unfortunately for themselves and their avi-fauna, they have imported the latter bird. They have also a goldfinch and a cuckoo of their own. This identity of names leads to confusion, and will never be rectified.

Report on Insects for the Year 1881. By J. Henry Comstock, Professor of Entomology in Cornell University. Washington: Government Printing-Office.

It may perhaps strike some of our readers as singular that so shrewd and practical a people as the Americans should have endowed chairs of Entomology in their Universities, and have appointed official entomologists in not a few of the States. Such a course of action will doubtless seem strange to men of mere literary culture, to the Popes of days by-gone no less than to the Ruskins of the present,—men who will not or cannot observe what overwhelming results spring from the continuous or ubiquitous action of agents individually trifling and feeble. The importance, or rather the necessity, of attending to the cumulative action of small things is one of the most precious of the lessons taught by our great Darwin, as well in his life as in his works.

Shrewd and practical? Precisely; and it is in virtue of that very shrewdness and practicality that the Americans have learnt the prodigious power of insects for good as for evil, and the interest which consequently attaches to their study. We, too, suffer at times heavily—both in the home kingdoms and still more in the Colonies—from insect depredators. But we are slow in understanding the lessons of such facts, and certain of our ethicists and æstheticists—blinder even than the utilitarians of the old school—still look upon Entomology as a frivolous pursuit.

In the Report before us Prof. Comstock describes certain insects, both harmful and beneficial, so that the public may know what to kill by every means in their power, and, on the other hand, what to spare and to protect.

The first species mentioned is the apple-maggot (*Trypæta pomonella*), a two-winged insect which in the larval condition

bores into the pulp of the apple, which is often honeycombed so as to be rendered perfectly useless. When mature it is a black and white fly, with banded wings. It originally fed upon certain species of hawthorn and upon crab-apples, but, by one of those changes of habit which we occasionally observe in insects, it has lately, in New York and the New England States, turned its attention to the cultivated apple. It attacks by preference the early species, and in some quarters has already rendered their cultivation unremunerative,

Two other noxious species are the "Pomace flies" (*Drosophila ampelophila* and *D. amœna*). These also belong to the order of two-winged flies, and, from having originally fed upon the decaying fruit found scattered on the ground in orchards, they have taken to haunt cider-mills, and vats in which grapes are fermenting. Here they have become quite a nuisance. Worse still, if a bird has made a hole in a grape these flies deposit their eggs in the pulp, and the larvæ bore from grape to grape till the whole cluster consists of nothing but empty skins.

All these insects are described at length, and figured for more easy recognition. We regret, however, to find that the distinguished author makes use of the neologisms of Prof. Wilder. Thus we read that, in the pupa of *D. amœna*, "the cephalic spiracles project directly *cephalad*." Such language, in a treatise which is intended not merely for scientific biologists, but for farmers and gardeners, seems to us not over-judicious.

Several of the ladybirds (Coccinellidæ) are described and figured, not by any means as enemies, but as valuable allies, which prey upon Aphides, scale-insects, &c., and therefore require to be known and preserved. A knowledge of their appearance and habits is now the more necessary, since by ignorant and careless observers they may be confounded with the Chrysomelidæ, to which group the dreaded Colorado beetle belongs. We have known an instance of a gardener who, till informed of his error, systematically destroyed the ladybirds, under the impression that they were either Colorado beetles or might turn into such.

As regards the methods used for the destruction of scale-insects, "doctors differ." Prof. C. V. Riley, the Entomologist to the Department of Agriculture, in a paragraph which has somehow been inserted in this work without the knowledge and consent of Prof. Comstock, recommends an emulsion of kerosene as the best agent, and as having been very satisfactorily used by the orange-growers in Florida. Prof. Comstock, on the other hand, recommends a solution of 1 lb. "concentrated lye" in 1 gallon of water, to be applied to the tree in winter, and to be supplemented if needful in the summer by a wash of ¼ lb. whale-oil soap in a gallon of water in which some sulphur has been boiled up. The "concentrated lye" in question is an impure alkali, containing 8·3 parts caustic potash to 91·7 parts caustic soda.

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Mention is also made of two American lac-insects (*Carteria larreæ* and *C. mexicana*), which secrete a matter supposed identical with the lac of India produced by *C. lacca*.

A new wax-producing insect, *Cerococcus quercus*, is also described.

The Mason College Magazine. Vol. I., No. 5, May, 1883. Birmingham: Cornish Bros.

On taking up this little magazine we expected to find something thought-provoking, and we were not disappointed. "Overtaking the Rays of Light," by M. J. H. Poynting, Professor of Physics, is a most remarkable paper, calculated to inspire even the ablest among us with a wholesome dread of dogmatism in our attempts at interpreting the universe. It has been beforetime suggested that a being able to take up its position at any given distance from the earth and endowed with an indefinitely increased power of vision, might see the past history of our earth pass in a strange panorama. But Mr. Poynting improves on the idea. He supposes an observer travelling to or from the earth at speeds comparable with that of light. Time would appear to be altered in scale, and even to be reversed. "If the observer were to quicken up his speed till he received twice as many luminous vibrations in the same time, the present colours would all move quite out of the range of his vision beyond the violet, and would be replaced by those long waves beyond the red, which we can now only perceive by their heating effects. The earth itself sends out such rays, and it would most likely appear to be a red-hot globe, while boiling water would be of dazzling brightness." On the other hand, by receding from the earth at a proper speed, but with his eyes still turned towards it, he would see the conclusions of events before their beginnings. These considerations, especially if taken in connection with certain suggestions made by Mr. W. Crookes, F.R.S. ("Journal of Science," 1879, p. 34), will show us what is the true nature, not merely of matter, but even of time and space.

"Another Point of View" is a sarcastic, but, we fear, too life-like sketch of students and of their doings in certain colleges.

At a meeting of the Union a debate on the Vegetarian question is reported. Miss B. Clarke, who introduced the subject, made the curious assertion that the deficiency of nitrogen in vegetables was to be made up by eggs, *butter*, and cheese, forgetting that butter has very slight claims to be called a nitrogenous body, that, like eggs and cheese, it is an animal product, and that all these three substances could be had only at prohibitive prices if the slaughter of fowls and cattle for food were to cease.

What shall we say at finding a ghost story, the scene of which, moreover, is laid near agnostic Birmingham?

A passage is here quoted from a letter of Edward Gibbon's, which conveys a wholesome lesson to those anxious to introduce theological discussions in such societies as the Mason College Union. Said the great historian to Joseph Priestley, "Leave Thaumaturgy to defend itself; it is chemistry which will make your reputation. Remember the end of your predecessor, Servetus. If his book on the Trinity is still preserved, it is only because it contains the first rudiments of the discovery of the circulation of the blood."

Footprints found at the Carson State Prison. By H. W. Harkness, M.D. (Reprinted from the "Proceedings of the California Academy of Sciences," August 7, 1882.

Most of our readers will by this time have heard mention, more or less definite, of the strange footprints recently brought to light in the State of Nevada, and which must rank amongst the most important pieces of evidence yet brought to light in favour of the high antiquity of the human race.

It appears that the Nevada State Prison lies at a distance of about a mile-and-a-half from Carson City, the capital of the State. In order to utilise the labour of the convicts in quarrying building-stone it was built on the extreme point of a hill of sandstone, evidently formed by the detritus brought down from the Sierra Nevada by the action of wind and water. From the side of this hill the stone has accordingly been cut away from an area of about 1¾ acres, and to the depth of 15 to 32 feet. The hill consists of layers of rock alternating with seams of clay. In one of these, which now forms part of the Prison yard, the footprints in question were detected. The impression produced upon the observer is that the deposit in which the footprints are seen must have been at one time the muddy shore of a lake or pond, and that various animals, in traversing this deposit, left deep impressions of their feet,—precisely such as may be seen whenever a man or other animal walks over wet mud. The footmarks are those of an elephantine animal (probably the mastodon), a deer, a wolf, perhaps a hyæna, several birds, and, above all, of a man, or at least of an anthropoid biped. Of human tracks there are six distinct sets, each consisting of from 1 to 17 prints, and each showing the impression of a sandal or rude shoe: in one of the sets the shape of this sandal was different from the others.

Some of these series of footmarks disappear beneath the walls

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of the quarry, but Mr. Garrard, the Governor of the Prison, who has taken an intelligent interest in the discovery, has run a tunnel under the face of the rock, and brought to light eight more footprints, four of which were found in the presence of Dr. Harkness.

According to Professor Le Conte, who has made a careful examination of the traces and the accompanying fossils, the deposit must be either Quaternary or Upper Pliocene, since no elephant or true horse is found in the American Miocenes. The evidence seems altogether in favour of the Quaternary or Upper Pliocene passing into the former.

On this part of the question there is a tolerable unanimity among the highest authorities. But it is asked:—Are we sure that the footprints are human? The size of the prints is the first difficulty. They are eighteen, and in some cases twenty, inches in length, and about eight inches in width. This seems at first sight a fatal objection. But if, with Dr. Harkness, we suppose the foot covered with a large clumsy shoe, it is perfectly possible that the tracks would be much larger than those made by a man walking with naked feet upon a comparatively firm ground, *e.g.*, a hard rock covered with a slight sprinkling of snow. It is especially to be noted that there are no marks of toes, claws, or hoofs. Professor Le Conte, however, remarks that no toe-marks or pad-marks were found in the tracks of the elephants.

Two other points have to be taken into consideration—the length of the stride and the width of the straddle. The stride is 2½ feet, "about the stride of an average man in a brisk walk," but in others more than 3 feet. This Prof. Le Conte considers too much for a man walking in soft mud. We have our doubts on this point: in boggy ground men often take extra long steps for the purpose of avoiding the wetter places. The width of the "straddle" is a greater difficulty. If we draw lines through the centres of the left and right feet respectively, these lines are about eighteen inches from each other. This is fully three times greater than that of an average man. But we have to consider in how far men wearing clumsy wooden sandals would get into the habit of walking with the legs wide apart. Another point to be noted is the outward turn of the foot, which, according to Prof. Le Conte, is "more than human." It will be remembered that the Red Indians, like all men who walk much among brushwood, deep herbage, &c., do not turn their toes outwards.

But if the human theory is not free from difficulties, the quadrupedal supposition is still more perplexing. As Prof. Le Conte says:—"The one strong argument for the bipedal theory is the singleness of the tracks and the absence of toe-marks. The one strong argument for the quadrupedal theory is the wide space between the right and left series of tracks." Whilst suspending his decision, he inclines to the notion that the tracks were due to a bear, or to the Mylodon, an extinct gigantic ground sloth.

Professor Marsh seems of the same opinion. On the other hand, C. Drayton Gibbes writes:—"Many frontiersmen of great experience in tracking Indians, and also bears and other wild animals, have witnessed these footprints, and all give their judgment without a question in favour of their human origin." Dr. Harkness expresses himself also as satisfied that the tracks are those of men. He remarks, very acutely, that if the impressions were those of any unshod animal, be it mammalian, biped, quadruped, or bird, they might differ in size, but would all be of the same pattern, which is not the case. Such a difference in shape becomes, however, quite intelligible if we suppose the footprints made by men wearing rudely-fashioned sandals.

The Students' Mechanics. An Introduction to the Study of Force and Motion. By WALTER R. BROWNE, M.A. London: C. Griffin and Co.

THE work before us, although especially designed for the use of students, has the valuable peculiarity of being non-examinational. The author, in his preface, remarks that the successful prosecution of Mechanics, especially as applied to practical construction, chiefly depends on the obtaining a clear and thorough mastery of a few leading principles, such as the composition of forces, the principle of moments, and the doctrine of energy, which are necessary for the solution of almost all the problems of ordinary practice. He takes occasion to add that whilst it is "easy to learn such propositions sufficiently for the purposes of an examination, it is by no means easy to know and understand them so thoroughly as to be able to use them freely and confidently in attacking questions of practical importance." His object is to assist the student in attaining such a true practical knowledge. He therefore brings forward the doctrine of central forces and the conception of energy at the very outset. We are bound to admit that his treatment of the subject is happy, and that students of fair intelligence, and desirous of gaining a genuine mastery of mechanical science, will find here what they require for their guidance.

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CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

FANCIES.

To the Editor of the Journal of Science.

SIR,—What are fancies? Are they not a struggling evolution of the mind? But men of Science despise these "fancies wild,"—this "poetry." Newton called the latter "ingenious nonsense"; but somehow the mind will keep creeping back to it; and has it never done a stroke for Science herself? "Fancy" can only suggest; it has no reason; it is the speaking of an inner mind, as it were, with which we have no definite connexion, or at least *fancy* so. Locke is harsh on the man that pretends he thinks in his sleep—pretends that thought is going on while "sensation" and "reflection" are at rest (as I take his "Essay," Book II., chap. 1). Yet how do men call out in the depth of sleep (when fancies are at their highest?), and often intelligibly? Evidently there *is* thought at work, working on previously acquired sensation maybe.

One is apt to ask, or fancy, as he gazes on a sleeper, Is that a remnant, left by evolution, of the old inanimate nature—lifeless dust? Is it temporarily passing through a stage inconceivably old in its experience? Does the tree sleep with never a waking? Surely a sleeping man is in something of that phase? Yet he thinks in it, although his memory does not retain anything. Our dreams are only remembered as we dream half awake,—sensation at work without correct reflection: the first "mind" was perhaps always "dreaming." Does a brute think correctly? The dog follows a scent, but it is continually reminded of it by its senses.

Why does the mind picture some objects more readily than others? Thus it is easy for me to clearly see in my mind's eye (though I find it difficult and curious to fix its locality) a chequered square with quadrants of four different colours; but let me attempt to *retain* any of the female faces I may conceive above a second alike, and I cannot do it. The brain is more used to the one than the other, showing probably the work of evolution in

the mind. Some say that all our understanding is the result of experience. Whence then came the impulses that cause a mere tiny babe to twist its face into the regular form of a "smile," when it might just as readily have assumed what an experienced mortal would call a "howling contortion"? But it is invariably the same; nor does it appear to be an easier position of the muscles than serenity—or howling.

Can we conceive what never was, *i.e.*, what our mind has not been able to compass with the senses at its disposal? If we are creatures of Evolution, how can we? Witness our thoughts of Time and Space; we cannot "*think* them." Our ideas of "heaven" and "hell" are extremely material; in the old Mystery plays they dressed up God—like the Pope!

The Spiritualist's idea is of something like a jet of steam—a vapour; it's only getting a little warmer! In fact we must have a parallel to speak from, all earthy and Earthly. How can we, then, conceive of the Sublime in the Hereafter, if we inherit it? Can we not see the possibility of a state of "things" we cannot possibly conceive? We are afraid to meet that great Strangeness we fancy will supervene after our decease; but we don't *know*, we have n't the least conception of what it will be: all our heavens are mere beautiful earths; "eye hath not seen, nor ear heard" is truer than we idly dream. 'Tis said the whole world is *in* our brain, a mere set of nervous concussions in this brain-box—that is life and being! The beautiful, hard-soft, sweetness and sour, music, the landscape, the passions, existence, love, the world, the glorious firmament on high, with all its blue ethereal sky, are what? Mere forces acting on our blind "grey and white matter." And yet knowing this, seeing it, we are still vain creatures, knowing not only all about ourselves, but also all the ins and outs of the plans of the Almighty: truly a big fancy!

The other day I read of a tree that "was in a fury and trembled with rage" at being transplanted. "Oh," you say, "there is a physical explanation for all this; some currents set up, or something." Well, then, that 's all we are!

Can we fancy that the existence of thought will ever be proved in plants? Is not "reflex action" thought, or something very like it? Another sense would probably kill us with terror in a few hours. We cannot be so ridiculous now-a-days as to fancy we are not capable of it. I was at a social gathering the other day, and saw gentlemen and ladies bolt straight up in the air for often 4 and 5 feet high, by mere expectancy and laying on of hands; three were enough. Can anyone tell me the reason of that? There is no fancy in what we see!

Altogether one is inclined to treat "sensible" fancies considerately, and, instead of calling it a diseased imagination, to think it may perhaps be a peep in at the future.—I am, &c.,

D. Y. C.

THE BRAIN THEORY OF MIND AND MATTER.

To the Editor of the Journal of Science.

SIR,—As I have been absent from England for some time, the May number of the "Journal of Science," containing a letter on the above subject from "T. P. L.," has only just come into my hands, and I now ask permission to make a brief rejoinder.

"T. P. L." will find his problem already solved, and his "conclusion" refuted, in an article entitled "Animal Automatism," which appeared in the "Journal" for April, 1882, so that only a few words of explanation are here necessary. I have said that all perceptions are merely subjective, and that the brain, *considered as a phenomenon*, must share in this subjectivity, but I have not asserted that nothing exists save perceptions. That would be equivalent to a denial of the possibility of any kind of action, or even of continuous and valid thought. Every man is forced by analogy to believe that there are human perceptions other than his own, but not generically different, and expressed by such signs and sounds as accompany his own moods of thought and feeling. By means of these tangible, visible, and audible symbols he holds intercourse with his fellow-creatures. Now, by acting upon that aggregate of physical phenomena called the body, he can modify the correlated psychical phenomena. Pain, for instance, can be relieved by the administration of suitable remedies; but if the body existed only as a phantasm in the mind of the physician, no modification of the passive mental picture could possibly affect the sensations of the patient. We must therefore conclude that the body has not merely a phenomenal, but also a real or noumenal existence; and as all feeling and thought can be ultimately traced to the grey matter of the cerebral hemispheres, it may well be said of the brain that it thinks, and therefore is.—I am, &c.,

C. ARDEN.

COSMIC DUST.

To the Editor of the Journal of Science.

SIR,—The lines of dust visible in houses in England pervading the streams of light which enter windows, or accidental apertures

in doors or shutters, have been accounted for by the hypothesis of Cosmic dust, which, as is said, pervades space, and consequently our atmosphere. If in England, then, also in Borneo. As a matter of fact, however, no such visible lines of illuminated dust are observed here. The houses of at least half the inhabitants of Borneo are built by the sides of rivers, on muddy banks, surrounded by forest. They are constructed of wood, the flooring generally quite 20 feet above the ground (Swiss lake dwellings), more often 40, and the walls and roofs are made of leaves of palms. It naturally enough often happens, especially after a blow, that apertures larger or smaller are made in the roof. The sun and sky may be seen through these apertures, and upon the floor may be observed a corresponding circle or oval of light, according to the time of day; but no connecting illuminated line. When one blows the smoke of a cigarette across the line of connection, *that* becomes at once illuminated. Therefore the theory of Cosmic dust should perhaps be no longer entertained.

And here occurs to me a query: How many of Mr. Editor's molecules would go to make up a particle of this Cosmic dust made visible to us by a line of light traversing a comparative darkened chamber? And again, How much of the sun's light and heat should we enjoy were space filled with such gross stuff? —I am, &c.,

Ol. DE CRESPIGNY.

NOTES.

In a scientific, and as we always thought non-political, contemporary we find an entire page devoted to the recent abortive "Affirmation Bill!"

If the "Academy" is not misinformed, the Canadian Collector of Customs has recently seized and confiscated a set of the works of Professors Huxley and Tyndall, and of Mr. Herbert Spencer, as "immoral and irreligious." So the British Empire still has a censorship of the press, administered not by scholars and thinkers, but by revenue officers! Happy thought: may it not be necessary in future to "examine" candidates for the Customs in criticism, ethics, and theology? Let a certain Department take this into due consideration.

Dr. Krause ("Kosmos") considers the close resemblance of certain moths (such as the so-called "humming-bird hawk-moth," and especially to *Macroglossa Titan*) is due to positive mimicry. The close resemblance may, it is suggested, protect the moths from the humming-birds which are apt to attack them. (But humming-birds, even of different species, attack each other.)

M. V. Burq ("Comptes Rendus") confirms the reported immunity of workers in copper from cholera and typhoid fever. The *Bon Accord* trade society, consisting of 300 to 400 bronze-turners, fitters, &c., has not, since its foundation in 1819, lost a single member by either of these diseases.

The epoch of wheat-harvest, in France, is retarded by three days where the altitude exceeds 100 metres.

Dr. Dœlter ("Petermann's Geog. Mittheilungen") finds that the Cape Verde Islands contain, along with eruptive rocks, limestones, slates, gneiss, &c., and have probably once been connected with the continent; not, however, directly opposite, but in a northern or north-eastern direction.

MM. Wroblewski and Olezewski ("Comptes Rendus") have obtained nitrogen as a colourless liquid by cooling it down to $-136°$ F., and gradually releasing it from a pressure of 150 atmospheres.

M. E. Cosson ("Comptes Rendus,") still combats the projected creation of an inland sea in Northern Africa, as, if practicable, of little utility.

M. Ch. Brongniart has published a treatise on a new fossil insect from the carboniferous strata of Commentry, and on the entomological fauna of the coal-measures.

According to M. R. Blanchard ("Comptes Rendus") the pyloric appendages of fishes digest energetically cooked starch; they act more feebly upon raw starch, and transform the albumenoids. They cannot emulsify and split up the fats, and are imperfect representations of the pancreas.

Dr. Langendorff ("Archiv. Anat. Phys.") asserts that in insects the nerve-centre for respiration is not in the head, as they can breathe for some time after decapitation.

The strange account of a haunted house in Berkeley Square, which we extracted some time ago from "Light," re-appears in the "Squire," though in a slightly different form.

Dr. Gerlach ("Naturforscher"), in an investigation on double monstrosities, shows that the presence of two *areæ pellucidæ*, of two distinct germinal vesicles, upon one yolk, is distinctly established. In Mammalia the confluence of two embryos during their development is possible.

According to H. H. Smith ("American Naturalist") some of the wild honeys of Brazil are violent purgatives, and some even decidedly poisonous.

It is said ("Light") that a spring of water flowing at the rate of 1000 gallons hourly has been discovered, at Avonmouth Docks, by means of the divining-rod. A Mr. Lawrence made he search.

Prince Bismarck has made the grimmest joke of the century. He has given in his adhesion to Anti-Vivisectionism! Our Bestiarian enemies must be proud of their new pervert—the man of blood and iron.

Some members of the Society for Psychical Research appear to have been mesmerising birds. They must beware lest this should be construed as a "painful experiment."

Dr. H. Müller ("Kosmos") finds that blues, violets, and certain reds are more attractive to bees than other shades. Scarlets, oranges, and certain bright yellows, which the author calls "fulgent colours," are unattractive. (These colours, as we have not long ago pointed out, are often accompanied by unpleasant odours.)

According to MM. E. and H. Becquerel the mean annual temperature of soil covered with turf is higher at the depth of 0·05 metre than that of similar soil denuded of vegetation, by 0·29° C.

Mr. A. E. Verrill ("Science") calls attention to parental instinct as an important factor in the evolution of species. The absence of this feeling may have greatly contributed to the extirpation of many powerful forms.

The Bestiarians have had a field day. Lord Shaftesbury and the Bishop of Oxford made themselves conspicuous, and Lord Coleridge "attended to take his share of the scorn and contempt which men of Science were ready to bestow,"—and which he has certainly done his best to merit. The gathering was of a very aristocratic character.

The "Stock-keeper" (which, by the way, lies under some suspicion of Bestiarianism) has a discussion on Prof. Thury's theory of alternate predominance of the sexes in successive generations. The editor seems to think that the ova are arranged in the ovaries in alternate order. "Ixion" and M. Dewsland show the baseless character of this supposition.

Mr. W. L. Carpenter, in a paper on "Science Demonstration in Board Schools," read before the Physical Society, denounced the present system of cramming for examinations.

"Vera," writing in "Light," pronounces Spiritualism "a field bristling with the most diabolical dangers to the human race."

M. Kanellis ("Comptes Rendus") establishes the distinction of the two functions of the liver; the epithelium of the interlobular tissue secretes the bile, and the cellules of the liver form the glycogenous matter.

M. Barthélemy ("Comptes Rendus") has studied the development of some eggs laid by a hen suffering from poultry-cholera. None of them came to perfection, and the blood of the chicks swarmed with bacteria.

Messrs. Powell and Lealand have recently produced a 1-12th oil-immersion objective having a numerical aperture of 1·47, 1·52 being the extreme theoretical limit: this is the largest aperture hitherto attained. The glass has, considering its short focal length, a large amount of working distance; the front is set in the usual way, instead of being mounted on a thin plate of glass, as has been hitherto the custom with oil-immersion objectives.

A rare slug which appears peculiar to Hampstead, Highgate, and Hanley Road, is said to give a slight electric shock when touched, occasioning a momentary numbness in the finger affected.

It has been noticed that in the neighbourhood of Epping Forest the starlings have taken to line their nests with the flower of the red garden daisy.

We find that some persons who are particularly sensitive to the bites of gnats and midges experience a return of the original irritation at regular intervals of twelve or of twenty-four hours. This fact seems to corroborate the view that gnats and mosquitoes are the bearers of malarial fever.

According to "Light" the Pope has fulminated against Spiritualists a curse little inferior in intensity to that which bears the name of Ernulphus.

A new journal, the name of which it is not necessary for us to mention, is winning favourable opinions in certain quarters by taking up a position unfriendly to Science, and talking about "Professor Hoaxley."

M. L. de Wecker ("Comptes Rendus") shows that the infusion of the seed of the jequirity (*Abrus precatorius*) contains a bacillus which, if applied to the human eye, produces purulent ophthalmia. This is the first instance of the transmission of an infectious disease by a plant.

Dr. O. Dammer ("Isis") has been engaged with experiments on the changes of colour produced in flowers by ammonia and sulphurous acid. He does not appear to have studied, like Mr. Nesbit, the action of other reagents.

The French ship *Talisman* set out on June 1st for the purpose of exploring the zoology of the regions of the Atlantic extending from the coasts of Morocco and the Canaries to the Cape Verde Islands, the Sargassian Sea, and the Azores. The head of the expedition is, as might have been expected, M. Milne Edwards.

According to "Science" the European sparrow displays much adroitness in robbing the American robin of its booty of earthworms.

A "familiar" of a certain Department thinks that if the fishsalesmen were compelled to pass a "stiff exam." before exercising their trade, the ring and its monopoly would come to an end. Possibly so; we have heard less likely results anticipated from examinations.

The Bestiarians held a conference at Edinburgh on May 26th, and expressed their "alarm" at the sensible conduct of the Home Secretary. May their alarm increase!

MM. Dujardin-Beaumetz and Audigé ("Comptes Rendus"), in a series of experiments, have confirmed the specially dangerous nature of absinthe as compared with ordinary alcoholic liquids.

M. Chicandard ("Comptes Rendus") shows that the fermentation of bread does not consist in a hydration of the starch, and is not occasioned by a *Saccharomyces*, but depends on a trans-

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formation of a portion of the insoluble albumenoids of the gluten into a soluble state, and ultimately into peptones. The starch is only modified by baking. The agent in panary fermentation is a bacterium which is normally developed in the paste; yeast merely accelerates the process.

MM. Van Tieghem and Gaston Bonnier (Société Botanique de France) show that grains of rye retain their power of germination even after desiccation at 176° F.—a temperature higher than that at which albumen is coagulated.

M. Pauchon ("Comptes Rendus") demonstrates that the upper limit of audibility may vary, for one and the same ear, with the intensity of the sound. Using a powerful syren, he found that with a pressure of steam varying from 0·5 to 1·5 atmospheres the limit ranged from 48,000 to 60,000 single vibrations; with a pressure of 2½ atmospheres the limit was not reached at 72,000 vibrations—the acutest sound which the syren was able to produce.

The French Government, in acknowledgment of the merits of Professor Pasteur, have increased his pension from £450 to £1000 yearly, and extended it to his wife should she outlive him.

MM. Fränkel and Geppert have studied the influence of reduced atmospheric pressure upon animal life. They find that at pressures corresponding to an altitude of 3800 to 4900 metres the proportion of oxygen in the blood is not diminished. At ⅓ atmosphere, corresponding to an altitude of 8800 metres, the arterial oxygen is reduced by one-half. The formation of carbonic oxide is reduced, but not in a corresponding proportion. The decomposition of albumenoids in the body, and consequently the excretion of nitrogen, are increased. The loss of blood from the mucous membranes is not due to direct mechanical action.

It is not generally known that the botanist A. M. Duchesne, as far back as 1766, upheld Evolutionary ideas, and even constructed a genealogical tree of the strawberry. He writes:—"L'ordre genealogique est le seul que la nature indique, le seul qui satisfasse pleinement l'esprit; tout autre est arbitaire et vide d'idées."

Mr. J. Amory Jeffries, writing in "Science," contends that Madagascar should be regarded as the remains of a fading zoological region, rather than a part of the Ethiopian.

Mr. J. Le Conte ("Science") shows that in very cold climates the sap of all perennial plants must be frozen in all parts during the winter months. Such congelation does not necessarily involve the death of the plant.

According to the experiments of Ewald and Kobert the lungs are not absolutely air-tight at high pressures ("Pflüger's Archiv.").

M. Netter professes to demonstrate experimentally the non-intelligence and the automatism of animals. He appears to have overlooked the circumstance that his demonstration, if valid, applies also to man.

The removal of the Geneva museum to a new building has, we learn, proved ruinous to a considerable part of the entomological collections. Let us hope that a better fate awaits the British Museum in its place of exile.

M. Cattaneo, in an elaborate work, combats the view of Perrier that the Mollusca, like the Articulata, are formed by the amalgamation of linear colonies.

Dr. de Chaumont ("Medical Press and Circular") in an interesting paper on the "Origin and Development of the Science of Hygiene," says—"Of the other writers of the period I will only refer to Thomas Philogus, of Ravenna, on account of his strong protest against intramural interment, thus anticipating by some three centuries the happily fruitful labours of our distinguished countryman Edwin Chadwick." Can Dr. de Chaumont have forgotten that the modern and successful protest against intramural interment was made by our distinguished countryman Dr. George Walker, once known all England over as "Churchyard Walker"?

Prof. Feser, by feeding rats exclusively upon animal food, rendered them incapable of contracting, by inoculation, splenic fever, to which other rats, fed on a vegetable diet, easily succumbed.

A writer in "Les Mondes" divides Evolutionists into three classes:—1. The atheists; Haeckel, Vogt, Büchrer, and their school. 2. The gnostic or positivist evolutionists; Herbert, Spencer, Tyndall, Huxley, Bain, and Littre. 3. The theistic Evolutionists; Owen, Sir John, Herschel, Sir William-Thomson, Prof. Gray, M. Vallace, M. Naudin." (We copy these names literally. It might be asked whether Sir J. Herschel and Sir W. Thomson have ever professed themselves Evolutionists, and also why the name of Darwin himself is omitted? A positivist Evolutionist is, since the death of G. H. Lewes, a rarity.)

Dean Swift's famous college of Brobdignag could not be more machine-like in its method of working than is the unwieldy thing we may call our modern system of education, with its standards and certificates, and payments by results, &c. But what are these results? We could understand there being some value attached to a good result. The result, however, is not

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education ; it is cramming, accompanied by enfeebled brain and waste of nervous tissue.—*Yorkshire Inventor.*

M. Gay-Lussac, son of the illustrious chemist Gay-Lussac, died early in June, at the age of 63 years. The deceased was a chemist of merit, and had published important reşearches in metallurgy.

Dr. Burdon-Sanderson, on his appointment to the Wayneflete Chair of Physiology, at Oxford, was very naturally desirous for his laboratory to be enlarged and improved. At a meeting of Convocation a grant of £10,000 from the University chest was proposed for this object. After much discussion the motion was carried only by the narrow majority of 3 ! The opposition is said to have been under Bestiarian influences.

Dr. Michael Foster is appointed to the new Chair of Physiology at Cambridge, and Dr. A. Macalister to that of Anatomy.

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